Labrador-Island Transmission Link

Environmental Impact Statement

Volume 2B
Biophysical Effects Assessment

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 11

Atmospheric Environment: Environmental Effects Assessment

April 2012

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

Acronym	Description
%	percent
% HA	percent highly annoyed
/yr	per year
<	less than
>	greater than
ac	alternating current
ATVs	all-terrain vehicles
BCMOE	British Columbia Ministry of Environment
C/ha	carbon per hectare
CCME	Canadian Council of Ministers of the Environment
CEA Agency	Canadian Environmental Assessment Agency
CH_4	methane
cm	centimetre
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
dB	decibels
dBA	decibels (A-weighted scale)
dc	direct current
e.g.	for example
EA	Environmental Assessment
EEA	European Environment Agency
EIS	Environmental Impact Statement
EPP	Environmental Protection Plan
ERCB	Environmental Resources Conservation Board
FHWA	Federal Highway Administration (United States)
GHG	greenhouse gas
GNL	Government of Newfoundland and Labrador
GNP	Great Northern Peninsula (of Newfoundland)
Gt	Gigatonne
GWP	global warming potential
ha	hectare
HDD	horizontal directional drill
hp	horsepower
hr	hour
HVdc	High Voltage direct current
Hz	Hertz
i.e.	that is

Acronym	**Description**
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KI	Key Indicator
km	kilometre
km/hr	kilometres per hour
km/L	kilometres per litre
KVA	kilovolt-amp
kW	kiloWatts
L	litre
L/hr	litres per hour
L/yr	litres per year
L_{50}	50th (median) percentile sound pressure level
L_{dn}	day night average sound level
L_{eq}	equivalent sound level
L_{max}	maximum sound pressure level
LSA	Local Study Area
m	metre
MP	Measurable Parameter
Mt	Megatonne (10^6 tonnes)
N_2O	nitrous oxide
NAAQO	National Ambient Air Quality Objectives
NL	Newfoundland and Labrador
NLDEC	Newfoundland and Labrador Department of Environment and Conservation
NO_X	nitrogen oxides
NRCan	Natural Resources Canada
NSA	noise sensitive area
PAHs	polycyclic aromatic hydrocarbons
PM	particulate matter, also called total suspended particulate
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
Project	Labrador-Island Transmission Link
ROW	right-of-way
RSA	Regional Study Area
SHERP	Safety, Health and Environment Emergency Response Plan
SO_2	sulphur dioxide
t/y	tonnes per year
TCR	The Climate Registry
US	United States
US EPA	United States Environmental Protection Agency
VEC	Valued Environmental Component

Acronym	Description
VOC	volatile organic compound
WHO	World Health Organization

11 ATMOSPHERIC ENVIRONMENT: ENVIRONMENTAL EFFECTS ASSESSMENT

This Chapter of the Environmental Impact Statement (EIS) presents the environmental assessment (EA) for the Atmospheric Environment, which includes Climate, Air Quality and Sound.

11.1 Valued Environmental Component Selection

The EIS is focused on Valued Environmental Components (VECs). VECs are aspects of the biophysical and socioeconomic environments which are of particular ecological and / or social importance, and which are likely to be affected (adversely or positively) by the proposed Labrador-Island Transmission Link (Project). VECs reflect identified scientific and community concerns regarding the Project and its likely effects, and are identified early in an EA as a result of questions and issues raised through consultations with governments, Aboriginal and stakeholder groups and the general public.

Initial direction and input into VEC selection for this EIS was obtained through the EIS Guidelines and Scoping Document (Government of Newfoundland and Labrador and Government of Canada 2011) issued to Nalcor Energy (Nalcor) following Aboriginal and public review. Following additional analysis by the EIS study team and as a result of Nalcor's consultation activities, that initial list of VECs was expanded and refined to include and reflect the key environmental components and issues that require detailed consideration in the EIS.

Atmospheric Environment was selected as a VEC for a number of reasons:

- the atmosphere has an intrinsic or natural value, in that its constituents are needed to sustain life and maintain the health and well-being of humans, wildlife, vegetation and other biota;
- greenhouse gas (GHG) emissions accumulate in the atmosphere and are a major factor in producing the greenhouse effect that is believed to influence climate;
- the atmosphere is a pathway for the transport of air contaminants to the freshwater, marine, terrestrial and human environments, presenting the contaminants in the form of varying concentrations or particle phase or gas phase deposition;
- releases of air contaminants to the atmosphere from the Project may cause effects on the air, the land and the waterways; and
- emissions in the form of unwanted sound from the Project may cause effects on the ambient sound near the Project.

11.2 Atmospheric Environment

11.2.1 Introduction

The Atmospheric Environment is that component of the environment that comprises the layer of air near the earth's surface to a height of approximately 10 kilometres (km) and is described by analysis of:

- Climate, which is characterized by the composite or 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 (typically a 30-year period). Emissions of GHG are also considered, as these are an important factor in the potential for climate change. The environmental effects of climate on the Project are addressed in Chapter 4.
- Air quality, which is characterized by the measure of the constituents of ambient air, and includes the presence and the quantity of air contaminants in the atmosphere.
- Sound, which is characterized by the type, character, frequency, intensity and duration of noise (unwanted sound).

Overall, the climate and GHG emissions of Newfoundland and Labrador (NL) are consistent across the province, with some variation across the four geographic regions of the Study Area (i.e., Central and Southeastern Labrador; Northern Peninsula; Central and Eastern Newfoundland; and the Avalon Peninsula). The variation in GHG emissions is due mainly to the presence of power stations or heavy industry at specific locations. The existing air quality in NL is representative of a rural and clean environment, at most locations, most of the time. The ambient sound pressure levels for much of NL are dominated by the sounds of nature, and range from 25 A-weighted decibels (dBA) to approximately 40 dBA. For more information on existing conditions, see Section 10.2.

11.2.2 Environmental Assessment Study Areas

11.2.2.1 Spatial Boundaries

The spatial boundaries for the assessment of environmental effects of the Project on Atmospheric Environment are based on the likely effect of the Project on the atmosphere due to Construction, and Operations and Maintenance activities. The spatial boundaries are comprised of the Local Study Area (LSA) and the Regional Study Area (RSA), and are based on a combination of experience with similar projects (Stantec 2010a; Jacques Whitford 2009; Jacques Whitford 2006) and professional judgment:

- LSA is the area where the majority of Project-related components and activities that are likely to affect the Atmospheric Environment VEC will occur. The LSA focuses on the 2 km wide transmission corridor while also considering the general nature and location of other Project components and activities (e.g., shoreline electrode sites, electrode lines, borrow sources, storage areas, temporary camps) and the 500 metre (m) wide Strait of Belle Isle submarine cable crossing corridor (Figure 11.2.2-1).
- RSA is the area extending 1 km out from each side of the LSA (Figure 11.2.2-1). As the final route of the right-of-way (ROW) will occur within the 2 km wide LSA, there is potential for effects on Atmospheric Environment to extend beyond the LSA (i.e., the 500 to 1,000 m zone of influence described above could extend up to 1 km outside of the LSA if the ROW were to be placed along the boundary of the LSA). The RSA is therefore sufficiently wide to capture any such effects (i.e., at this distance, atmospheric releases from Project-related activities are likely to be sufficiently dispersed to meet the regulatory objectives, guidelines and standards).

The concept of defining an LSA and RSA is not applicable for the assessment of Project-related environmental effects on climate and GHGs. With respect to GHG emissions and in recognition of the global nature of the potential environmental effects of a change in GHG emissions on global climate, the spatial boundary for the assessment of the environmental effects of GHG emissions on the Atmospheric Environment is the global environment, with regional and provincial comparisons used to provide perspective.

11.2.2.2 Temporal Boundaries

The temporal boundaries for the assessment of likely effects of the Project on the Atmospheric Environment include the Construction period (approximately four years in total), and the Operations and Maintenance of the Project that is likely to continue in perpetuity. These periods are further defined in the Project Description (Section 3.4.1).

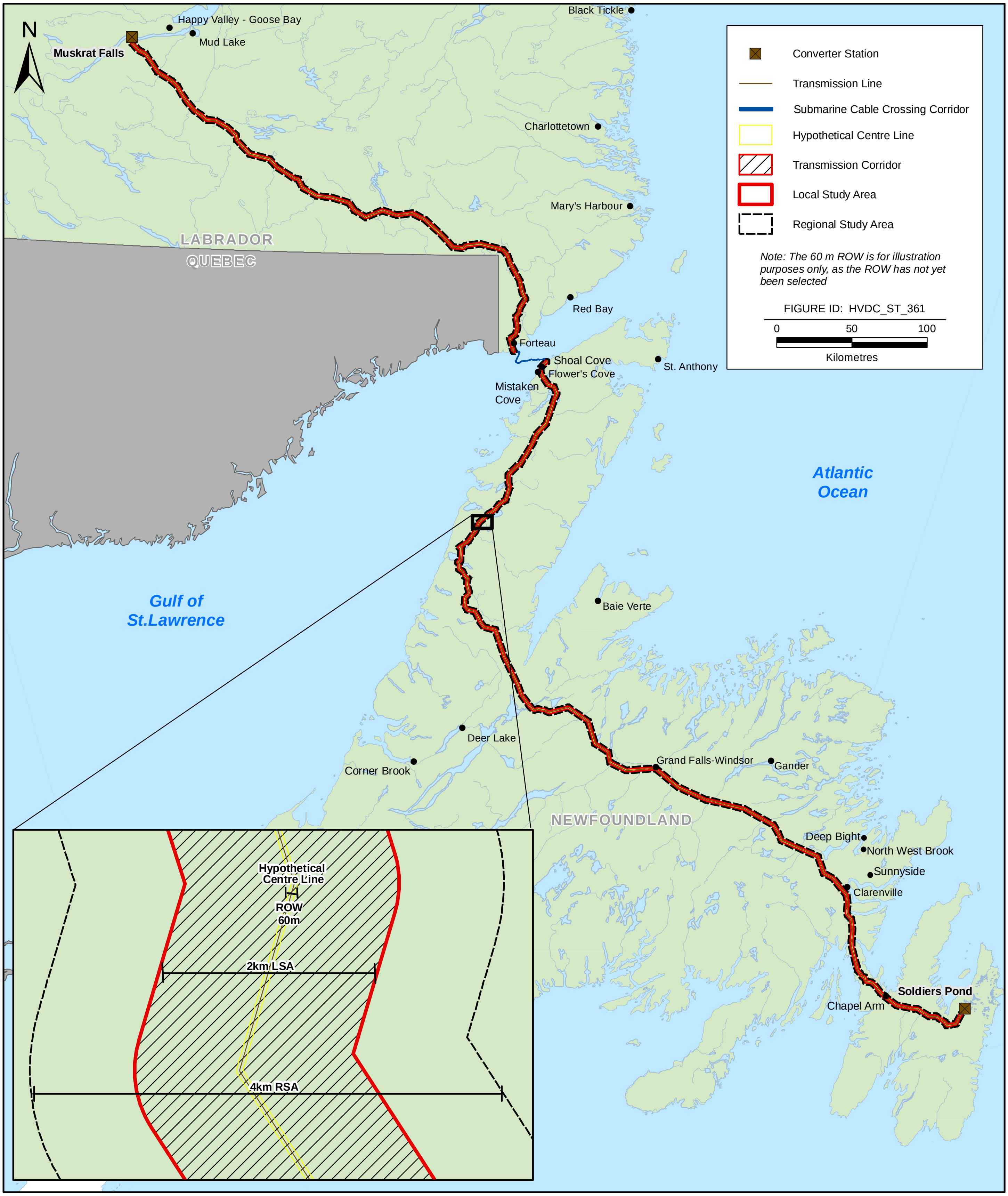


FIGURE 11.2.2-1

Local Study Area and Regional Study Area for the Atmospheric Environment

11.2.3 Potential Environmental Issues, Indicators and Interactions

11.2.3.1 Potential Environmental Issues

Stakeholder consultation identified issues and concerns with Project emissions and potential effects on the Atmospheric Environment. Specific concerns are noted in Table 11.2.3-1, along with other issues and concerns that frequently arise in relation to projects of this nature.

Table 11.2.3-1 Identified Issues and Questions: Atmospheric Environment

Issue / Question	Nature and Rationale	Specific Considerations
Climate		
GHG emissions	There is potential for Project-related GHG emissions (carbon dioxide (CO_2), nitrous oxides (N_2O) and methane (CH_4)) to contribute to the global concentration of GHGs in the atmosphere	– GHG emissions from vehicles and heavy equipment; any reduction or increase in carbon sequestration
Air Quality		
Combustion gases and dust generation during construction	There is potential for Project-related emissions to exceed objectives, guidelines, or standards on occasion	– Combustion gases from vehicles and heavy equipment – Dust is of concern during dry and windy conditions during ground breaking activities and / or vehicle traffic on the roads
Sound		
Sleep disturbance and annoyance to communities	During the Construction phase, concerns may arise due to the number and type of heavy equipment working near residences	– Health Canada (2009) identifies places of worship, schools, cultural significance, retirement homes and medical facilities in addition to residences, as locations of concern
Disturbance to wildlife[a]	Impulse noise, vehicle traffic and blasting during Construction or Operations and Maintenance may cause wildlife to temporarily avoid the area	– Sensitivity may be greater during specific seasons (e.g., breeding season, late winter)
Annoyance during Operations and Maintenance	Coronal discharge noise from the transmission line may cause annoyance at affected sensitive locations	– Health Canada (2009) identifies places of worship, schools, cultural significance, retirement homes and medical facilities in addition to residences as locations of concern

(a) Project-related effects from a change in Atmospheric Environment (i.e., Sound) on wildlife are addressed in the respective VEC sections.

11.2.3.2 Key Indicators and Measurable Parameters

The Atmospheric Environment is an essential support element for the natural environment. Climate (GHG emissions), Air Quality and Sound were selected as Key Indicators (KIs) of the Atmospheric Environment VEC (Table 11.2.3-2) due to the potential for Project activities to result in the release of emissions that may affect each of these KIs. These KIs receive considerable local, national and international attention in terms of existing and proposed legislation, development of action plans and international agreements. The rationale for the KIs and their respective Measurable Parameters (MPs) are presented in Table 11.2.3-2.

Table 11.2.3-2 Key Indicators and Associated Measurable Parameters: Atmospheric Environment

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Climate	– GHG emissions are identified as being an important influence on climate change – GHG emissions associated with the Project are an aspect of Climate that must be considered in the EA (Canadian Environmental Assessment Agency (CEA Agency) 2003, internet site) – Recent federal government policies and regulations are focused on GHG reduction[(a)(b)]	– GHG emission rates of CO_2, N_2O and CH_4 resulting from the Project	– The inventory and analysis of GHG emissions are widely recognized when assessing related environmental effects on climate (CEA Agency 2003, internet site)
Air Quality	– Air contaminants released from Project activities may affect the quality of the ambient air – Air Quality is important from a biophysical and socioeconomic perspective	– Concentrations and emission rates of air contaminants that include Particulate Matter (PM), PM less than 10 microns (PM_{10}), PM less than 25 microns ($PM_{2.5}$), sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), total volatile organic compounds (VOCs) and total polycyclic aromatic hydrocarbons (PAHs) resulting from the Project	– Air Quality is characterized by chemical and physical properties of the atmosphere, as affected by the release of combustion gases and particulate matter into the atmosphere (e.g., NO_X, PM, and SO_2) – Regulatory objectives, guidelines and / or standards exist provincially and federally for the MPs (Section 10.2; British Columbia Ministry of Environment (BCMOE) 2009, internet site; Health Canada 2006, internet site; Government of Newfoundland and Labrador (GNL) 2004, internet site; Canadian Council of Ministers of the Environment (CCME) 2000, internet site)

Table 11.2.3-2 Key Indicators and Associated Measurable Parameters: Atmospheric Environment (continued)

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Sound	– Unwanted sound emissions from Project activities will contribute to an increase in ambient sound pressure levels – An increase in ambient sound is important from a biophysical and socioeconomic perspective – A number of jurisdictions, including, for example, the provinces of Alberta and Ontario and the United States Environmental Protection Agency (US EPA), have specific regulatory limits for sound pressure levels from industrial or Construction activities	A-weighted sound pressure levels in decibels (dBA) for 1-hour L_{eq}[c]; and L_{dn}[d], L_{50}[e] computed from hourly L_{eq} values resulting from the Project	– Sound is typically characterized in terms of the type, character, frequency, intensity and duration of sound emissions. As the human ear does not respond to sound on a linear scale, ambient sound pressure levels are characterized using a logarithmic decibel (dB) scale, with the dBA scale being the most commonly used for environmental sound assessments – dBA are the most commonly measured by sound level meters, most commonly tabulated for equipment specifications, and most commonly included in legislation

[a] On June 23, 2010, the Government of Canada announced a commitment to reduce GHGs and improve the air quality nationally by taking action sector-by-sector. In support of the goal to be a "clean energy superpower", draft regulations to reduce GHGs from the electricity sector are expected to be published in the Canada Gazette in 2011 and final regulations published later that year. These regulations are scheduled to come into effect on July 1, 2015 (Environment Canada 2010a, internet site). Further to this, the federal government, in keeping with the national standards of the United States (US), has published (on April 1, 2010) draft regulations mandating an average 5 percent (%) renewable fuel content in gasoline, as well as draft regulations to reduce GHGs from passenger vehicles. Such initiatives mark the commitment set forth in the Copenhagen Accord to reduce Canada's GHG emissions 17% from 2005 levels by 2020, an objective that reflects the importance of Canada's recent alignment with US policy (Environment Canada 2010b, internet site).

[b] The Newfoundland and Labrador Department of Environment and Conservation (NLDEC) has prepared a Climate Change Action Plan (NLDEC 2005, internet site) in response to increasing concern for and awareness of these issues. Although firm GHG emission objectives have not been set, there is a strategy for NLDEC to manage its own GHG emissions from increased electricity demand and to offset GHG emissions from traditional energy sources by up to 15 million tonnes per year.

[c] "Equivalent sound level" ($L_{eq)}$) represents an equivalent energy level over a specified period of time (e.g., 1-hour (hr) or 24-hr). The hourly L_{eq} is used to derive the other metrics.

[d] For the assessment of community health impacts, Health Canada (2009) advocates the day-night average sound level (L_{dn}). L_{dn} is a 24-hour sound level in decibels obtained after applying a 10 dB penalty to sound levels during the night, 2200 to 0700 hrs. The nighttime penalty is because people tend to be disturbed by noise more at night than during the day.

[e] L_{50} (the median sound pressure level) is a sound pressure level that is exceeded 50% of the time for the period under consideration.

11.2.3.3 Potential Project-Atmospheric Environment Interactions

To identify the ways that the Project would likely affect the Atmospheric Environment, interactions are summarized in Table 11.2.3-3. Where the interaction will likely result in a change to another environmental component (i.e., an indirect effect), this is also presented.

Table 11.2.3-3 Potential Project Interactions: Atmospheric Environment

<table>
<tr><th rowspan="2">Project Phase / Activity</th><th colspan="3">Key Indicator</th></tr>
<tr><th>Climate (GHG emissions)</th><th>Air Quality</th><th>Sound</th></tr>
<tr><td colspan="4">Construction</td></tr>
<tr><td>Construction access trails and roads</td><td>– Direct: Generates GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere; reduction in carbon sequestration due to tree removal</td><td rowspan="5">– Direct: Generates emissions of air contaminants from the combustion of fuel and dust from heavy equipment and vehicle movement</td><td rowspan="6">– Direct: Generates sound from equipment and vehicle movement
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Movement and presence of personnel, equipment and materials</td><td rowspan="3">– Direct: Generates GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere</td></tr>
<tr><td>Construction camps</td></tr>
<tr><td>Marshalling yards and staging areas</td></tr>
<tr><td>ROW clearing and preparation</td><td>– Direct: Generates GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere; reduction in carbon sequestration due to tree removal</td></tr>
<tr><td>Quarrying and borrowing</td><td>– Direct: Generates GHG emissions from the combustion of fuel and removal of vegetation, which contributes to the global concentration of GHGs in the atmosphere</td><td rowspan="2">– Direct: Generates emissions of air contaminants from the combustion of fuel and dust from heavy equipment, vehicle movement and blasting</td></tr>
<tr><td>Transmission tower assembly and installation</td><td>– Direct: Generates GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere</td><td>– Direct: Generates sound from equipment and vehicle movement and blasting
– Indirect: Potential annoyance to nearby receptors</td></tr>
</table>

Table 11.2.3-3 Potential Project Interactions: Atmospheric Environment (continued)

<table>
<tr><th rowspan="2">Project
Phase / Activity</th><th colspan="3">Key Indicator</th></tr>
<tr><th>Climate (GHG emissions)</th><th>Air Quality</th><th>Sound</th></tr>
<tr><td>Conductor installation</td><td>– Direct: Generates GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere</td><td rowspan="3">– Direct: Generates emissions of air contaminants from the combustion of fuel and dust from heavy equipment and vehicle movement</td><td>– Direct: Generates sound from equipment and vehicle movement
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Converter station site preparation and construction</td><td>– Direct: Generates GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere; reduction in carbon sequestration due to tree removal</td><td>– Direct: Generates sound from equipment and vehicle movement, and possible blasting
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Preparation and construction of submarine cable landing sites (on-land works)</td><td rowspan="4">– Direct: Generates GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere</td><td>– Direct: Generates sound from equipment, vehicle movement, rock quarrying and horizontal directional drill (HDD)
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Construction and installation of submarine cables (marine works)</td><td>– Direct: Generates emissions of air contaminants from the combustion of fuel</td><td>– Direct: Generates sound from equipment
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Electrode site preparation and installation</td><td rowspan="2">– Direct: Generates emissions of air contaminants from the combustion of fuel and dust from heavy equipment and vehicle movement</td><td rowspan="2">– Direct: Generates sound from equipment and vehicle movement
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Island system upgrades</td></tr>
<tr><td>Employment / presence of workers</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Contracting / expenditures</td></tr>
</table>

Table 11.2.3-3 Potential Project Interactions: Atmospheric Environment (continued)

<table>
<tr><th rowspan="2">Project Phase / Activity</th><th colspan="3">Key Indicator</th></tr>
<tr><th>Climate (GHG emissions)</th><th>Air Quality</th><th>Sound</th></tr>
<tr><td>System commissioning</td><td>– Direct: Generates small quantities of GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere</td><td>– Direct: Generates small quantities of emissions of air contaminants from the combustion of fuel and dust from heavy equipment and vehicle movement</td><td>– Direct: Generates sound from equipment and vehicle movement
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td colspan="4">Operations and Maintenance</td></tr>
<tr><td>Access trails and roads</td><td rowspan="3">– Direct: Generates small quantities of GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere</td><td rowspan="4">– Direct: Generates small quantities of emissions of air contaminants from the combustion of fuel and dust from vehicle movement</td><td>– Direct: Generates sound from equipment and vehicle movement
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Presence and operation of the transmission system</td><td>– Direct: Generates sound from coronal discharge
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Routine line inspections and repairs</td><td rowspan="3">– Direct: Generates sound from equipment and vehicle movement
– Indirect: Potential annoyance to nearby receptors</td></tr>
<tr><td>Vegetation management</td><td>– Direct: Generates small quantities of GHG emissions from the combustion of fuel (including equipment used during vegetation management) and contributes to the global concentration of GHGs in the atmosphere; reduction in carbon sequestration due to tree removal</td></tr>
<tr><td>Potential major system repairs</td><td>– Direct: Generates small quantities of GHG emissions from the combustion of fuel and contributes to the global concentration of GHGs in the atmosphere</td><td>– Direct: Generates small quantities of emissions of air contaminants from the combustion of fuel and dust from heavy equipment and vehicle movement</td></tr>
</table>

Table 11.2.3-3 Potential Project Interactions: Atmospheric Environment (continued)

Project Phase / Activity	Key Indicator		
	Climate (GHG emissions)	**Air Quality**	**Sound**
Operation of the electrodes	—	—	– Direct: Generates sound from coronal discharge – Indirect: Potential annoyance to nearby receptors
Employment / presence of workers			—
Contracting / expenditures			

— No likely or detectable interaction identified.

11.2.4 Approach to the Environmental Effects Analysis

The air quality in each of the five geographic regions was described in Section 10.2.2 (Atmospheric Environment Existing Conditions). The air quality for Newfoundland and Labrador is characteristic of a clean, rural environment with few large sources of emissions. This characterization of the ambient environment is considered in relation to the releases to the Atmospheric Environment resulting from all components of the Project to conduct the assessment. Consequently, the likely environmental effects are considered for the Project in its entirety instead of by region.

11.2.4.1 Analytical Methods

The analytical methods for the assessment of Atmospheric Environment take into consideration all Project activities, using both qualitative and quantitative approaches.

As a first step in the assessment, the interactions of the Project activities with Atmospheric Environment are identified at a high level for Climate (GHG emissions), Air Quality and Sound, and ranked based on potential to result in adverse environmental effects. This ranking is used to inform the decision as to whether the potential effect requires a detailed analysis (with or without dispersion modelling) or less comprehensive analysis. Analyses may be done quantitatively, qualitatively or more commonly by a combination of the two. This form of screening analysis is an essential part of the assessment methods.

Where it is determined that a more detailed analysis is needed, a quantitative assessment is conducted. A detailed inventory of emissions or releases from the relevant Project-related activities is prepared, available data on the meteorology, topography and ambient conditions of the area are obtained and analyzed and formatted for use in predictive modelling where needed. Modelling is conducted using regulatory approved models, to predict the potential concentrations of air contaminants and / or noise levels at nearby sensitive receptors. The predicted values from the Project are added to the background levels of the area, and the totals are compared with the regulatory standards for different averaging times. In some cases, the frequency of exceeding a specific threshold is calculated. The thresholds may be the actual regulatory standard, or a value that is some fraction of the standard, such as 10%, or 50% of the objective, guideline or formal standard.

For some weak interactions, a detailed analysis is not warranted and a qualitative assessment is conducted. In this case, a bank of knowledge on similar activities, mitigation measures, and releases to the environment, is combined with professional experience to assess whether the Project-related activities have the potential to cause the ambient standards to be exceeded.

Where releases to the atmosphere are continuous (e.g., GHG, regulated air contaminant and noise), and where the emission rates or noise levels are high in magnitude (e.g., boiler or furnace, a power plant, a petroleum refinery, a municipal solid waste energy-from-waste plant, a diesel engine, blasting), detailed analyses including modelling are warranted.

Releases to the atmosphere may also be intermittent, and non-continuous, with low emission rates of GHGs, air contaminants, or noise at low sound pressure level. These types of releases may include exhaust from a few vehicles on a paved road in a rural setting, or from vehicles and equipment used for power line maintenance. For these releases, the more detailed analysis is not needed to make a prediction of likely environmental effects.

In between these two cases, the decision on whether to conduct a more detailed analysis is based on factors such as professional judgement, regulatory regimes or stakeholder concern. The decision on whether modelling is warranted for the assessment can be based on experience with similar activities, types and quantities of releases, and knowledge of the specific location planned for the Project. An informal process for this decision is followed, where the assessor considers the aspects described above and makes the decision. Often, but not always, the decision to conduct modelling is strongly influenced by the local regulatory agency and the public during consultation on scoping of the Project, early in the EA process. In many instances, the assessor uses discretion to make the decision. For the assessment of this Project, a more formal methodology was used for considering these aspects and rendering the decision on whether or not to conduct a more detailed analysis that includes modelling.

Once the nature of the relevant activities is understood, the quantities of emissions and the duration of a specific source at any one location are the two main metrics for the basis of the decision to conduct a more detailed analysis. Where the release quantities are relatively small and where the source location is temporary, a detailed analysis by dispersion modelling is not warranted. Exceptions to this may include a release of a hazardous air pollutant or where the location is adjacent to a sensitive receptor. In these cases, a decision is made at the discretion of the assessor after careful consideration of the above conditions.

For Climate (GHG emissions) and Air Quality, the potential effects of the Project-related releases are quantified and placed in context with the regulatory requirements, using a combined qualitative and quantitative approach (in the absence of dispersion modelling). For Sound, the same combined approach is used with noise modelling to aid in estimating sound pressure levels anticipated from the Project.

Climate (GHG emissions)

The estimates of likely GHG emissions from Construction, and Operations and Maintenance are made on the basis of carbon released to the atmosphere during combustion of fossil fuels from equipment used for the Project. The estimates are made using published emission factors (Intergovernmental Panel on Climate Change (IPCC) 2007; IPCC 2006a, b; US EPA 1996a, internet site) combined with fuel consumption rates of the equipment. The estimates are then compared to the total emissions from the province, from Canada and globally, to provide context for the changes to GHG emissions associated with the Project. Predictive modelling of project-related GHG emissions is not standard practice and has not been conducted here.

It is important to emphasize that the methodology of estimating GHG emissions takes into account global warming potentials (GWPs). In this assessment, the equivalent carbon dioxide (CO_2e) quantities of GHGs are calculated using the 100-year GWPs as follows:

- CO_2 GWP = 1;
- CH_4 GWP = 21; and
- N_2O GWP = 310.

Emission factors from the IPCC (2006a) for mobile, off-road equipment were used, along with the estimated diesel consumption for each Construction activity to predict the likely release of GHGs to the environment. Fuel consumption by passenger vehicles was not disaggregated from the total diesel consumption, and therefore, GHG emissions from vehicles are included in those for off-road construction equipment.

During clearing of the transmission line ROW, an area of approximately 3,900 hectares (ha) will be cleared. Vegetation that exceeds 2 m in height at maturity will be cut along the ROW (Section 3.4.3). Depending on the growth stage of the forest, this clearing may represent a loss of carbon sequestration. This loss or reduction in carbon sequestration is estimated from information on the area of the ROW and the land use classes (and carbon content) over that area.

There are currently no provincial or federal standards or guidelines for GHG concentrations in ambient air, nor are there any emission limits with respect to GHG releases from individual sources or sectors in place for Newfoundland and Labrador at this time. As such, the scope of this Project does not contain any aspects that are currently regulated for GHG emissions provincially or federally.

The latest guidance from the CEA Agency (2003, internet site), "Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners" was followed for this environmental assessment. As summarized in the introduction of that document, GHGs as precursors to climate change constitute a global phenomenon rather than a local issue, and the science of this phenomenon is not yet developed to the stage where global environmental effects from a single project of this nature can be measured. Following CEA Agency guidance, "*the environmental assessment process could not consider the bulk of GHG emitted from existing developments. Furthermore, unlike most project-related environmental effects, the contribution of an individual project to climate change cannot be measured*" (CEA Agency 2003, internet site). This presents a technical boundary in that the contribution of the Project to global climate change ultimately cannot be established at this time under current guidance.

In light of this, CEA Agency (2003, internet site) recommends evaluation of the net changes in GHG emissions as a result of a project and consideration of detailed mitigation if GHG emissions are found to be medium or high (note that these terms are not defined in the document). Based on descriptions of project activities in the CEA document, it is logical to consider an industrial source, such as a fossil-fuelled electrical generating station and / or a petroleum refinery as a high GHG emitter, and a pipeline project or a hydroelectric facility as a low GHG emitter. GHG emissions resulting from Construction of the Project, due to the temporary nature and low overall fuel consumption compared to large utility and industrial emitters, are thus closer to the low end of this range in magnitude.

Following the guidance (CEA Agency 2003, internet site), the Project-related effects on Climate (GHG emissions) are assessed by conducting a preliminary scoping of GHG emissions, determining jurisdictional considerations (including GHG policies or plans) and by considering the magnitude, intensity and timing of Project emissions. Specifically, consideration is given to the quantities of GHG emissions resulting from the Project and the relative amounts compared to provincial, national and global GHG emissions. As recommended by the CEA Agency (2003, internet site), a GHG Management Plan will only be prepared if GHG emissions are considered either medium or high.

Air Quality

Several different and key features of the Project-related activities were considered in the analysis of effects on Air Quality. These include:

- the nature of the Project-related activities, including an understanding of the specific activity that may release air contaminants to the atmosphere, for example combustion of fossil fuel in construction vehicles, and heavy equipment;
- the nature of the release to the atmosphere, including releases from an industrial stack, a vent, a storage tank, a fugitive release near the ground, exhausts from vehicles, trucks, heavy equipment, marine vessels;
- the types and quantities of substances that may be released to the atmosphere, including air contaminants (e.g., SO_2, NO_x, CO, VOCs, PAHs), dust, PM, PM_{10} and $PM_{2.5}$, and GHGs (e.g., CO_2, N_2O and CH_4);
- the length of time that the release is expected to occur, including whether the source is a continuous release, an intermittent non-continuous release that cycles regularly over a specific period of time, or a non-continuous or intermittent release that is expected to occur but not at regular intervals;
- the location of the potential release relative to nearby sensitive receptors, including the distance from the release point to the nearest residence, school or hospital;
- a consideration of the meteorology of the area, including an analysis of wind speed, wind direction, prevailing winds during each season and annually, and precipitation patterns;
- the ambient air quality of the area, where data are available;
- the methods, policies, procedures and equipment that are planned to minimize the releases to the atmosphere, for each activity, including Nalcor's full list of mitigation; and
- the extent of dispersion of the air contaminants from the release point to the nearby receptors, and the potential for the Project-related releases to cause the ambient regulatory standards to be exceeded.

Following this methodology (i.e., screening and ranking of different Project activities and the likelihood and their environmental effects on Air Quality), a combined quantitative and qualitative assessment has been conducted in the absence of dispersion modelling. During Construction, and Operations and Maintenance, the releases to the atmosphere would consist primarily of combustion gases and particulate matter from fuel consumption in heavy equipment and airborne dust from fugitive sources (e.g., dust from heavy equipment activities or trucks on unpaved roads). Further, given the nature of Construction, and Operations and Maintenance activities and air contaminant emissions (i.e., minimal and temporary), both dispersion modelling and supplementary ambient air quality monitoring were not warranted for this assessment. Nevertheless, the Project-related environmental effects on air quality are considered quantitatively and qualitatively.

The emission estimates from construction equipment (e.g., heavy equipment and marine vessels) and Construction activities (e.g., blasting and HDD), as well as Operations and Maintenance equipment and activities (e.g., truck, chainsaw and helicopter), are considered in conjunction with the ambient air quality (Section 10.2.2). This is completed to establish the potential for the Project to cause the ambient objectives, guidelines or standards (presented in Section 10.2.2) to be exceeded. The emissions inventory is based on the equipment specification, expected hours of operation of each unit, and estimated fuel consumption (US EPA 1985, internet site) and emission factors from the United States Environmental Protection Agency (US EPA) (1996a, b, internet sites).

As such, changes in Air Quality are assessed in the context of likely Project-related releases of air contaminants (Table 11.2.3-2) and the ground-level concentrations of these air contaminants in the LSA and RSA.

Sound

Sound emissions may result from Project Construction, and Operations and Maintenance through the operation of construction equipment (i.e., cranes, excavators, HDD, blasting), coronal discharge and maintenance activities (i.e., all terrain vehicles (ATVs), helicopters). Therefore, an evaluation of the likely effects of the Project on ambient sound levels was undertaken as a part of this assessment.

The evaluation involved estimating ambient sound levels along the transmission corridor, identifying potentially sensitive noise receptors, predicting the sound emissions related to Project Construction, and Operations and Maintenance, adding the predicted sound pressure levels to the current background levels, and comparing the results to available noise standards and guidelines.

Baseline sound level monitoring along the transmission corridor was not conducted for this EA. Instead, this assessment relied on the methodology and information published by the Alberta Energy Resources Conservation Board (ERCB) (2007) to characterize the ambient sound levels in rural and / or remote areas. In Alberta (and later adopted in British Columbia), the energy permitting agencies (i.e., ERCB) 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 forests, and professional experience of the Atmospheric Environment Study Team at similar areas, it was concluded that no substantive difference exists between the assumed ambient levels, such as those implemented in western Canada, and the majority of the LSA and RSA. As such, ambient sound levels along the transmission corridor were assumed to be 45 dBA during the day (0700 to 2200 hrs) and 35 dBA during the night (2200 to 0700 hrs).

Where the LSA and RSA are in close proximity or overlap with larger communities and cities, the ambient sound levels of these areas were assumed to be 5 dBA higher, 50 dBA during the day and 40 dBA during the night. According to the ERCB (2007), these representative values of remote areas are appropriate for use in the absence of baseline monitoring. Further to this, the assumed values are similar to those measured by the Study Team from other baseline monitoring studies in remote areas such as Ridley Island (British Columbia), Fort McMurray (Alberta), Lameque (New Brunswick), Digby (Nova Scotia), and Voisey's Bay (Newfoundland and Labrador) (Stantec 2010a).

Potential noise sensitive receptors include residences, daycares, schools, hospitals, places of worship, nursing homes and any sites where socially significant First Nations cultural or religious ceremonies take place (Health Canada 2009). The majority of the transmission corridor is distant from communities, towns and cities. However, in terms of the Project, any residential areas, communities, towns or cities within the RSA were characterized as a noise sensitive area (NSA). The NSAs and their approximate distance from the LSA boundary (i.e., nearest point where construction activity may take place) are presented in Table 11.2.4-1.

Table 11.2.4-1 Identified Noise Sensitive Areas and Approximate Distances to the Local Study Area

Noise Sensitive Area	Approximate distance to the Local Study Area (m)
Forteau, Labrador	750
Shoal Cove, Newfoundland	Within the LSA
Sandy Cove, Newfoundland	Within the LSA
Savage Cove, Newfoundland	Within the LSA
Mistaken Cove, Newfoundland	Within the LSA
Flower's Cove, Newfoundland	850
Grand Falls-Windsor, Newfoundland	500
Clarenville, Newfoundland	500
Deep Bight, Newfoundland	1,250
North West Brook-Ivany's Cove, Newfoundland	800
Sunnyside, Newfoundland	Within the LSA
Chapel Arm, Newfoundland	Within the LSA
Whitbourne	Within the LSA
Blaketown	Within the LSA
Holyrood	Within the LSA

Estimates of sound emissions and corresponding sound pressure levels from equipment and activities associated with the assembly and installation of towers and the preparation and construction of submarine cable landing sites and installation of submarine cables were used to assess likely environmental effects from construction. Predictions of representative sound pressure levels resulting from the Construction of the Project were then made using the CadnaA model (Computer Aided Noise Abatement, version 4), based on the sound power levels. The CadnaA model is a recognized sound attenuation model and is in full compliance with the predictive methods of ISO 9613-1 and ISO 9613-2 (International Organization for Standardization (ISO) 2003).

Natural factors typically influence ambient sound levels in the outdoor environment (e.g., wind, waves, birds, animals) and human activities (e.g., construction equipment, vehicle traffic, sporting events) also have an influence. Weather conditions such as temperature, humidity, wind direction and wind speed affect the distance that sound travels through the atmosphere. In addition, changes in the physical properties of the environment (e.g., such as a change in land cover, or the removal or construction of physical structures such as buildings) can result in changes to the sound propagation characteristics of the environment. Sound pressure levels naturally decrease with increasing distance from the sound emission source and local topographical features, such as hills or heavily wooded areas, reduce the transmission of sound. The CadnaA noise model accounts for the following:

- distance attenuation (i.e., geometrical dispersion of sound with distance);
- atmospheric attenuation (i.e., the rate of sound absorption by atmospheric gases in the air between sound sources and receptors);
- ground attenuation (i.e., effect of sound absorption by the ground as sound passes over various terrain and vegetation types between source and receptor);
- screening effects of surrounding terrain; and

- meteorological conditions and effects.

Estimates of noise generated by operating transmission lines were derived from published research on coronal noise. Sound pressure levels were predicted for coronal discharge noise and Aeolian noise, for comparison with the presumed ambient sound levels (ERCB 2007). Occasional maintenance activities (i.e., helicopters, ATVs) are assumed to have a negligible contribution to long-term ambient sound levels. The predicted sound pressure levels at the NSAs were added to the background noise and compared to noise guidelines. Where the predicted levels exceed guidelines, mitigation measures are proposed.

Regulated limits for noise emissions are not imposed in NL unless by operating permit or as a requirement of an EA. Since there are no noise guidelines or standards in the province, Health Canada's approach to noise assessments was adopted for this Project. Health Canada provides advice through a review process that sets out specific requirements for their information needs based on concern over noise and its ability to cause effects to community health (Health Canada 2009). Their concern is directly related to the proximity of humans to a project's activity. Health Canada EA guidance (Health Canada 2009) recommend a separate assessment of potential environmental effects on Sound for daytime and nighttime. Noise during the nighttime hours is perceived as more intrusive and of concern with regard to the potential for sleep disturbance. The World Health Organization (WHO) established a guideline of 30 dBA inside a dwelling to avoid sleep disturbance (WHO 1999, internet site). Health Canada uses the percent of the nearby population that would be highly annoyed (% HA) metric as an assessment measure for human health impacts, and this is based on long-term composite averages of day and night sound pressure levels (Health Canada 2009).

Health Canada's draft guidance document on noise assessments for CEA Agency projects (Health Canada 2009) also addresses projects that have construction periods greater or less than one year. The method for assessing effects of long-term construction is based on calculating the % HA using the procedure published in ISO 1996-1:2003 (ISO 2003). If the % HA increases by 6.5% or more with mitigation, compared to the baseline condition, then the potential environmental effect may be of concern. For Operations and Maintenance, the % HA is also calculated using the same procedure, for the baseline and the baseline plus operation conditions. If, after mitigation has been applied, the % HA increases by 6.5% or more, the potential environmental effect may be of concern and additional mitigation may be needed. In terms of schools and pre-schools during Construction, and Operations and Maintenance, the predictions for the Project are compared with the values in the Health Canada (2009) guidance. A summary of Health Canada's (2009) guidance to noise assessments is provided in Table 11.2.4-2.

The environmental effect of noise on birds and mammals was of concern to reviewers interested in natural resources, and was assessed differently because the environmental effect on wildlife was more closely related to impulse sounds that cause startle and flee responses. The assessments of likely environmental effects from noise on the respective wildlife VECs are discussed in the corresponding sections.

Table 11.2.4-2 Summary of Health Canada's Guidance to Assessing Noise

Phase	Criterion	Limit	Period	Rationale	Reference
Construction (less than (<) 1 year)	L_{dn}	<62 dBA	Day-Night	Likelihood of widespread complaints	US EPA as adopted by Health Canada (2009)
Construction (<1 year) and Operation	% HA	Change in % HA <6.5%	Day-Night	Annoyance is deemed to be a community health impact	Health Canada (2009)
Construction (greater than (>) 1 year) and Operation	% HA	Change in % HA <6.5%	Day-Night	Annoyance is deemed to be a community health impact	Health Canada (2009)

Table 11.2.4-2 Summary of Health Canada's Guidance to Assessing Noise (continued)

Phase	Criterion	Limit	Period	Rationale	Reference
Construction (>1 year) and Operation	Sound pressure level indoor at schools	L_{eq} <40 dBA	Class time	Maintenance of 100% speech intelligibility indoors	Health Canada (2009)
Construction (>1 year) and Operation	L_{eq} and maximum sound pressure level (L_{max}) indoors at schools, hospitals, senior residences, any sites where socially significant First Nations cultural or religious ceremonies take place	L_{eq} <30 dBA; fewer than 10 to 15 exceedances of 45 dBA	Night	Sleep interruption	WHO as adopted by Health Canada (2009)

11.2.4.2 Environmental Effects Descriptors

As indicated above, the likely effects of the Project were assessed for climate (GHG), Air Quality and Sound. The likely effects on climate (GHG), Air Quality and Sound from the relevant Project activities were characterized using a combination of environmental effects descriptors. The definitions of these descriptors are presented in Table 11.2.4-3.

Table 11.2.4-3 Environmental Effects Descriptors: Atmospheric Environment

Effects Descriptor	Definition		
	Climate (GHG)	Air Quality	Sound
Direction			
Adverse	Effect is worsening or is undesirable	Effect is worsening or is undesirable	Effect is worsening or is undesirable
Neutral	Effect is not changing compared with baseline conditions and trends	Effect is not changing compared with baseline conditions and trends	Effect is not changing compared with baseline conditions and trends
Beneficial	Effect is improving or is desirable	Effect is improving or is desirable	Effect is improving or is desirable
Magnitude			
No effect	Effect does not occur	Effect does not occur	Effect does not occur
Low	Effect occurs that might not be detectable, but is within the normal range of variability; is slightly affected but is below objectives, guidelines or standards[a]	Effect occurs that might not be detectable, but is within the normal range of variability; is slightly affected but is below objectives, guidelines or standards[a]	Effect occurs that might not be detectable, but is within the normal range of variability; is slightly affected but is below noise guidelines[a] selected for the Project
Moderate	Effect occurs but is unlikely to exceed the objectives, guidelines or standards	Effect occurs but is unlikely to exceed the objectives, guidelines or standards	Effect occurs but is unlikely to exceed the ambient noise guidelines selected for the Project

Table 11.2.4-3 Environmental Effects Descriptors: Atmospheric Environment (continued)

Effects Descriptor	Definition		
	Climate (GHG)	**Air Quality**	**Sound**
High	Effect occurs and is likely to exceed the objectives, guidelines or standards	Effect occurs and is likely to exceed the objectives, guidelines or standards	Effect occurs and is likely to exceed the ambient noise guidelines selected for the Project
Geographic Extent			
Local	n/a	Effect will be limited to the LSA	Effect will be limited to the LSA
Regional	n/a	Effect will be limited to the RSA	Effect will be limited to the RSA
Beyond regional	Effect extends beyond the RSA (i.e., global)	Effect extends beyond the RSA	Effect extends beyond the RSA
Duration			
Short-term	Effect will be evident for less than one year	Effect will be evident for less than one year	Effect will be evident for less than one year
Medium-term	Effect will be evident for between one and four years (associated with construction)	Effect will be evident for between one and four years (associated with construction)	Effect will be evident for between one and four years (associated with construction)
Long-term	Effect will be evident for longer than four years, but does not extend more than 30 years	Effect will be evident for longer than four years, but does not extend more than 30 years	Effect will be evident for longer than four years, but does not extend more than 30 years
Far future	Effect will be evident throughout Project operations	Effect will be evident throughout Project operations	Effect will be evident throughout Project operations

n/a not applicable.
[a] Section 10.3; BCMOE 2009, internet site; Health Canada 2006, internet site; GNL 2004, internet site; CCME 2000, internet site.

11.2.5 Construction

11.2.5.1 Overview of Project Construction and Associated Effects Management

Nalcor has Environmental Policy and Guiding Principles that are designed to maintain a high standard of environmental responsibility and performance through the implementation of a comprehensive environmental management system. Following the guiding principles of 'Preventing Pollution', 'Improve Continually', and 'Comply with Legislation', Nalcor is committed to reducing adverse environmental effects to the extent practical.

During Construction, the activities that are relevant to Atmospheric Environment are:

- the use of heavy equipment that includes bulldozers, excavators, mechanical harvesters, trucks, cranes, and HDD rigs;
- use of marine vessels during installation of the cable and placement of the protective rock berms;

- use of helicopters;
- use of chainsaws and ATVs during clearing of the ROW;
- blasting during foundation preparation for the transmission towers and terminal stations; and
- storage of raw material (e.g., aggregate storage piles of soil or gravel).

These activities may result in the release of air contaminant emissions (including dust), GHGs, and sound to the atmosphere. In addition, clearing of vegetation could result in a loss of carbon sequestration. While this is a potential longer-term effect, it is addressed within the assessment of Project Construction as it is the result of vegetation clearing of the various Project components.

Following the federal guidance (CEA Agency 2003, internet site), the Project will be completed in a manner that will be sensitive to the minimization of air contaminant and GHG emissions. While the overall GHG emissions from the Project will likely be "low" as per the classification in CEA Agency (2003, internet site), management measures will nevertheless be incorporated to mitigate GHG emissions from the Project. Mitigation proposed by Nalcor includes the following:

- vehicles and equipment must comply with the relevant federal vehicle emissions and energy efficiency standards that are applicable at that time;
- engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic;
- well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed;
- during windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust;
- haul distances for construction material will be limited to the extent practical;
- dust complaints will be addressed on a case by case basis and mitigation (e.g., dust control) will be considered locally as appropriate; and
- fire suppression mitigations such as routine maintenance on equipment to prevent overheating and electrical issues that could cause fires, proper handling and storage of fuels as per the environmental protection plan (EPP), fire suppression systems available as per the EPP.

Short-term construction-related increases in noise will occur during Construction. These noises would likely result from, but are not limited to, the operation of chainsaws and heavy equipment needed to fell and handle timber, grade the access roads, dig footings and foundations, erect structures, and string conductors. Noise increases will be localized and transient, exposing portions of the ROW for a limited time as construction proceeds along the ROW. However, during this period, noise can affect land use activities. In this Project, the most intrinsic construction activity, erection of the tower, will last approximately four days. Construction of other components, such as the converter stations, shoreline electrodes and HDD of the shore approaches for the Strait of Belle Isle submarine cable crossing, will occur at specific locations over extended periods of time (i.e., up to several years depending on the component).

As described in Section 3.4, Construction will be completed in a manner such that work in any area is conducted as expeditiously as safety allows with mitigation in place to minimize noise exposure at sensitive receptors. Locations for Project components such as converter stations, shoreline electrode sites and the HDD were selected in consideration of receptor locations to minimize exposure to noise.

A combination of mitigation measures will be employed for the Project, especially those activities undertaken within 150 m of residences, schools, medical facilities, retirement homes and places of spiritual importance, so that the Health Canada (2009) noise limits are met inside these facilities. Mitigation proposed by Nalcor include the following:

- Construction activities will be conducted in accordance with municipal by-laws regarding noise.
- High noise-producing construction equipment will be strategically placed as far away as practical from receptors.
- All equipment will have appropriate mufflers and will be well maintained.
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.
- The size of explosive charges will be limited during blasting activities to the requirement of the blasting activities.
- Sound barriers or berms will be used at the HDD site in Shoal Cove, if practical, to minimize sound pressure levels leaving the site.
- Frequent and open communication will be conducted with nearby residents to identify and address any noise complaints. Complaints will be addressed on a case by case basis and mitigation options investigated. This could include temporary relocation during high sound generating Construction activities (i.e., blasting).

11.2.5.2 Existing Knowledge

Through previous experience of the Study Team (Stantec 2010b; Jacques Whitford 2009; Jacques Whitford 2006) and a review of relevant literature, summaries of existing knowledge on the effects from construction of similar projects on the Atmospheric Environment are presented for Climate (Table 11.2.5-1), Air Quality (Table 11.2.5-2) and Sound (Table 11.2.5-3).

Table 11.2.5-1 Existing Knowledge (Construction): Environmental Effects of Similar Projects on Atmospheric Environment (Climate – Greenhouse Gas Emissions)

Reference	Study / Project Context	Summary of Findings
ICF International (2010)	Mitigation measures for transportation construction	Possible mitigation includes reducing equipment activity, improving fuel economy, and using alternative engine technologies and fuels
Lee et al. (2009)	Monitoring of GHG emissions at construction sites	GHG emissions at construction sites are highly variable and difficult to measure. Often times the activity data required (fuel consumed and / or equipment operating hours) are unavailable pre- and post-project
IPCC (2007)	Global warming potentials for GHGs	100-year global warming potentials used to estimate total GHG emissions as CO_2e
IPCC (2006a, b), US EPA (1996b, internet site)	Emission factors for diesel combustion in industrial context	Values were taken from these sources to estimate GHG emissions from construction activities

Table 11.2.5-2 Existing Knowledge (Construction): Environmental Effects of Similar Projects on Atmospheric Environment (Air Quality)

Reference	Study / Project Context	Summary of Findings
Sonoma Technology Inc. (2010)	Construction activity, emissions, and air quality impacts	Off-road emissions have increased over time due to increased activity and relatively long life of equipment. Possible mitigation measures include (but are not limited to): use of new equipment, retrofit of old equipment, curtail or control activity, and increase distances between activity and sensitive receptors.
Georgia Transmission Corporation (2008a, b); Burns & McDonnell Engineering Company Inc. (2007)	Linear facility EAs from Canada and United States	Emissions of air contaminants from equipment and construction activities are temporary and localized to the construction area. No long-term significant environmental effects were predicted.
Guggemos and Horvath (2006)	Assessing the environmental effects of constructing commercial buildings	New equipment is preferred over older equipment to reduce air pollutant emissions.
Cheminfo Services Inc. (2005)	Reduction of air emissions from construction and demolition activities	Develop an environmental action plan to reduce dust and other air pollutants from activities. Factors to consider include (but are not limited to): phased grading, surface stabilisation with vegetation, reduce or eliminate idling times, and minimize distances travelled for the delivery of material.
Jahren (2000, internet site)	Transportation construction equipment	Non-road diesel equipment can emit more air pollutants than on-road trucks and buses. In urban environments, compliance with local ambient air quality standards may be difficult.
New York State (1989, internet site)	Dust control	A number of dust control measures may be undertaken at the construction site, including (but not limited to): watering of roadways, covering piles, and restricting vehicle speeds.
US EPA (1996a, b, internet sites); US EPA (1985, internet site); US EPA (1980, internet site)	Average properties of diesel fuel, emission factors for diesel combustion in heavy (<600 horsepower (hp)) equipment, emission factors for blasting explosives	Values were taken from these sources to estimate emissions of air contaminants from construction activities.

Table 11.2.5-3 Existing Knowledge (Construction): Environmental Effects of Similar Projects on Atmospheric Environment (Sound)

Reference	Study / Project Context	Summary of Findings
Advanced Engineering Acoustics (2010)	Construction noise threshold criteria and control measures	Noise due to construction is temporary. A number of factors are related to the potential impacts of noise, including (but not limited to): location of sensitive receptors, type / phase of construction, and the site layout. Sound pressure levels produced during Construction depend on several factors, including (but not limited to): type of equipment used, the care employed by the operator, and the condition of the equipment.
Health Canada (2009)	Health Canada Guidance to Assessing Noise	These guidelines were used in the assessment of sound quality resulting from the Construction of the Project.
ERCB (2007)	Ambient sound pressure levels	Reference data provided by the Alberta ERCB were used for this assessment.
Federal Highway Administration (FHWA) (2006)	Construction equipment sound pressure levels	The sound pressure levels provided in this document were used when predicting sound pressure levels resulting from the Construction of the Project.
Gilchrist et al. (2003)	Urban construction	In urban environments, construction noise can be disturbing. A noise control program can be developed to address this issue. Such a program includes identifying potential sensitive receptors, determining background sound pressure levels, predicting noise from construction activities, and applying mitigation as needed. It is important to communicate with the public, monitor sound level in and around the site, and enforce noise restrictions.
Eaton (2000, internet site)	Construction noise	Construction noise may be managed by avoiding noisy processes, scheduling noisy activities during periods of high background noise, and isolating noisy processes from sensitive receptors. Other mitigation measures are available if required.

11.2.5.3 Construction Effects: Climate (GHG emissions)

GHG Emissions from Project Equipment

Construction activities will occur over a four year period (Section 3.4). On the linear components (e.g., transmission line ROW) work activity will occur along the length of the Project, in a sequential manner. The majority of the GHG emissions will be generated by operation of the HDD rigs, marine vessels, mechanical harvesters and heavy construction equipment (Table 11.2.5-4). This equipment list, along with the estimated fuel consumption (Table 11.2.5-5), was used to estimate the GHG emissions (Table 11.2.5-6).

Table 11.2.5-4 Typical Equipment Required during Construction

Transmission Line	Converter Stations
All terrain crane	Graders (140 hp)
ATVs	Concrete vibrator
Bulldozer (300 hp)	Backhoe (up to 7 cubic yards bucket capacity)
Chainsaws	Track loader (2 cubic yards)
Concrete mixer	Concrete batch plant
Dump truck	Boomtrucks (5 and 10 ton)
Excavator	Compactor (15 ton)
Grader (200 hp)	Crawler crane (100 ton)
Hydraulic press	Bulldozer (up to 305 hp)
Horizontal directional drill rigs	Hydraulic drill (5 inch diameter)
Muskeg tracked vehicle	Hydraulic crane (40 tonnes)
Puller	Gasoline generator sets (15 kiloWatts (kW))
Sandblasting machine	Diesel generator set (320 kW)
Tensioner (on trailer)	Truck mounted post hole auger
Loader	Water pump
Tractor trailer	Tractor
Truck with pole digger	Light duty trucks
Light duty trucks	Ice plant (100 tonnes)
Water truck	Concrete mixer and truck
Water pump	Flatbed truck
Marine vessels (for pipe laying and rock placement)	Mechanical harvester
Mechanical harvesters	

Table 11.2.5-5 Estimated Diesel Consumption during Construction

Location	Diesel (L) for Each Year				
	Year 1	Year 2	Year 3	Year 4	Year 5[(a)]
High Voltage direct current (HVdc) transmission line – Labrador	2,108,900	4,217,900	4,217,900	4,217,900	1,054,500
HVdc transmission line – Newfoundland	3,730,800	7,461,500	7,461,500	5,596,200	—
Cable landing site – Labrador	—	411,200	616,800	—	—
Cable landing site – Newfoundland	—	514,000	514,000	—	—
Strait of Belle Isle	—	—	1,231,900	6,576,000	—
Converter Station – Labrador	865,300	1,730,600	1,730,600	1,730,600	—
Electrode site and overhead line – Labrador	—	—	239,100	318,900	—
Converter Station – Newfoundland	351,000	1,404,000	1,404,000	1,404,000	—
Electrode site and overhead line – Newfoundland	—	—	92,400	369,600	—
Newfoundland system upgrades	724,800	1,449,600	1,449,600	1,449,600	1,087,200
Subtotals (litres per year (L/yr))	7,780,800	17,188,800	18,957,800	21,662,700	2,141,700
Total litres (L)	**67,731,800**				

— Indicates that no construction activities are planned in this location during this year.
(a) Construction will occur over four years in total, from year one to year five of the Project.

Table 11.2.5-6 Emissions of Greenhouse Gases from Construction

Greenhouse Gas	Year 1 (t/y)[(a)]	Year 2 (t/y)	Year 3 (t/y)	Year 4 (t/y)	Year 5[(b)] (t/y)	Total (tonnes)
Carbon dioxide	22,015	48,634	68,607	101,168	6,060	246,484
Methane	1.23	2.72	3.82	5.59	0.34	13.7
Nitrous oxide	8.50	18.9	19.3	16.7	2.3	65.7
Carbon dioxide equivalent	24,675	54,545	74,671	106,448	6,792	267,131

(a) t/y = tonnes per year.
(b) Construction will occur over four years in total, from year one to year five of the Project.

GHG emissions were estimated based on default diesel emission factors from US EPA (1996b, internet site) and IPCC (2006a, b). For CO_2, the emission factor assumes 100% conversion of fuel carbon to CO_2. Since the majority of GHG emissions are from CO_2, total GHG emissions are conservatively overestimated. The maximum GHG emission in any one year of construction, associated with equipment use, is 106,448 tonnes carbon dioxide equivalent (CO_2e) per year (in Year 4), and the total GHG emissions from Project Construction is 267,131 tonnes CO_2e (Table 11.2.5-6).

Clearing of the ROW

During clearing of the transmission line, approximately 3,900 ha of vegetation (that exceeds 2 m in height at maturity) will be cut to within 15 centimetres (cm) of the ground along the ROW (Section 3.4.3). This area will be subject to vegetation management activities (Section 3.5.2.3) that will keep the vegetation at an early successional stage (i.e., low growing plants) throughout the life of the Project.

Left undisturbed, actively growing forests in north-eastern North America accumulate carbon and sequester atmospheric carbon dioxide (Wofsy 2004). Accordingly, clearing of this forest represents a loss of carbon stock and the loss of carbon sequestration. This carbon loss was estimated by:

$$C_{Stored} + C_{Sequestered} = C_{Loss}$$

Where:

C_{Stored} = the carbon stored as biomass in above ground vegetation (tonnes carbon per hectare (C/ha))

$C_{Sequestered}$ = the net growth of plants and the sequestration of carbon (tonnes C/ha)

C_{Loss} = the total loss of carbon sequestration and biomass carbon from clearing of the ROW (tonnes C/ha)

Malhi et al. (1999) estimated the amount of carbon stored in the above tree biomass as 49.2 tonnes C/ha, for a uniform, mature boreal forest (approximately 115 years in age), developed after a fire. For the purpose of estimating the biomass carbon loss associated with clearing of the ROW for the Project, this carbon storage value is herein adjusted to 24.6 tonnes C/ha (50% less), to account for portions of the province that are less densely forested along the length of the transmission corridor.

Generally, slightly more CO_2 is fixed by plants than is released to the atmosphere, resulting in a net growth of individual plants and the sequestration of carbon at 0.680 tonnes C/ha per year (/yr) (Malhi et al. 1999). Fans et al. (1995), who measured a net boreal forest sink in Québec of 0.790 tonnes C/ha/yr, further support this. For the purpose of the Project, carbon sequestration under existing conditions is assumed to be an average of these two values (i.e., 0.735 tonnes C/ha/yr).

Based on the equation, the assumptions above, and the fact that the 3,900 ha of vegetation clearing will occur over a four year period, the estimate of total loss of carbon sequestration and biomass carbon from clearing of the ROW is 393,822 tonnes CO_2e (98,456 tonnes CO_2e/yr). This is a conservative estimate of loss of carbon sequestration and biomass carbon that would include effects of the clearing required for all the various Project components (e.g., access), as there will be early successional vegetation regenerating within the ROWs of the transmission line and electrode lines.

Total GHG Emissions

In consideration of the total GHG emissions from Project Construction (267,131 tonnes CO_2e total) and the loss of carbon (biomass and sequestration) associated with clearing of the ROW and all of the various Project components (393,822 tonnes CO_2e), the total GHG emissions from Project Construction is 660,953 tonnes CO_2e.

The maximum GHG emissions in any one year of construction will be approximately 204,904 tonnes CO_2e. The total GHG emissions reported by facilities in Newfoundland and Labrador in 2008 were 5.2 megatonnes (Mt) CO_2e (Environment Canada 2010c, internet site), and the total GHG emissions reported in Canada in 2008 were 0.26 gigatonnes (Gt) CO_2e (Environment Canada 2010d, internet site). Therefore, the maximum yearly GHG emissions during Project Construction will represent approximately 3.9% of the province's annual GHG emissions, and 0.08% of Canada's annual GHG emissions, assuming the GHG emissions from other sources remain the same as 2008 levels.

Global emissions of GHGs were 32 Gt in 2006 (Climate Analysis Indicator Tools 2010, internet site). The maximum yearly GHG emissions released during Project Construction are 2.0×10^{-4} Gt CO_2e. Assuming that all other global sources of GHGs remain constant, the emissions released during Construction (including loss of carbon sequestration associated with clearing of the transmission line) represent a small fraction (<0.05%) of global emissions.

Emissions from a Project-induced fire (i.e., small contained fire, small brush fire) could include GHGs. Interactions may thus occur with a change in GHG emissions. While the emissions are likely to be measurable during the short-term event, with the planned mitigation (such as routine maintenance on equipment to prevent overheating and electrical issues that could cause fires, proper handling of flammable materials, designated smoking areas, good housekeeping practices, fire suppression systems and incident response plans), substantive fires are considered unlikely to occur and any fire is expected to be of low magnitude and short in duration. The changes resulting from a Project-induced fire are unlikely to substantively influence long-term ambient conditions.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Climate are as follows:

- Adverse, because construction activities will result in releases of GHG to the atmosphere;
- Of low magnitude, because the releases are directly related to the combustion of fossil fuels in heavy equipment and trucks, and this will not be medium or high;
- Beyond regional (i.e., global) in geographic extent; and
- Of long-term to far future duration, because of the long timeframe that GHGs can persist in the atmosphere.

The mitigation measures to minimize adverse environmental effects of the Project on Climate will be implemented wherever technically and economically feasible. Given the likely low magnitude of these releases to the atmosphere, the low frequency of occurrence, and the mitigation that will be applied, the releases of GHGs during Construction are likely to be low in the context of the CEAA (2003) guidance.

There is a high degree of confidence in the prediction of GHG emissions associated with Construction (including carbon loss from clearing required for the Project). This is due to the conservative assumptions made for fuel estimates, those made for the estimation of carbon loss from clearing of the transmission ROW and the scientific certainty in the emission factors used (IPCC 2006a, b) in calculating the estimates. The mitigation measures to reduce environmental effects of Construction on the Climate (GHG emissions), which include measures such as equipment maintenance and reduction in idling, are proven and accepted methods.

11.2.5.4 Construction Effects: Air Quality

Emissions from Combustion and Blasting

Activities associated with site preparation (e.g., clearing, grubbing, blasting), proposed ROW clearing, installation of the transmission line, and vehicle traffic on-site will be the largest sources of air contaminants (PM, PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, total VOCs, and total PAHs) for the Project. There is also the potential for fugitive emissions of PM (dust) from several of the Construction activities including clearing, grading, and blasting. Nalcor will not burn slash or other debris during Construction. The estimates of air contaminants from Construction include activities at and within the Strait of Belle Isle, on-highway transport of equipment and materials, emissions from construction equipment and the emissions of fugitive dust.

For Construction activities related to the submarine cable crossing of the Strait of Belle Isle, the following conservative assumptions have been made:

- two drill rigs will operate on either side of the Strait for 2.5 years continuously; each drill consumes diesel fuel at the maximum horsepower rating throughout its operation;

- the marine vessel laying the cable will operate for six months continuously; the on-board engines burn diesel fuel at the maximum engine rating throughout their operation;
- the marine rock placement vessel will operate for six months continuously; the on-board engines burn diesel fuel at the maximum engine rating throughout their operation; and
- in each case, the emissions have been estimated as uncontrolled (i.e., no emissions control equipment in place).

The release of air contaminants from blasting (tower construction) has been estimated based on preliminary information, and the following assumptions:

- a maximum of five blasts will be required for the installation of suspension towers;
- a maximum of 12 blasts will be required for deadend towers; and
- up to six sticks of dynamite will be required per blast.

Vehicle traffic volume estimates for the transportation of heavy equipment and materials during on-highway transport of equipment and materials are not currently known. However, since these trips will be on highways, and at normal speeds with minimal stopping and starting, and will occur at various times throughout the day, air contaminant emissions from trucks during deliveries will disperse quickly in the atmosphere and are unlikely to substantively influence ambient air quality. Emissions of air contaminants from passenger vehicle traffic are therefore expected to be nominal (i.e., essentially zero), and have not been included in emission estimates for Project Construction.

The Construction of the Project will require heavy equipment for the excavation and movement of earth materials, as well as the clearing of vegetation. The amounts and types of equipment used will vary depending on the construction contractor, the terrain and vegetation types encountered and the type of Construction activity. The air contaminant emissions estimates for construction equipment are based on emission factors obtained for diesel generators (US EPA 1996a, 1985, internet sites). The expected types of heavy equipment per year for Construction of the Project are presented in Table 11.2.5-4.

The estimated total consumption of diesel fuel for Project Construction is 68 million L, and; the fuel breakdown by year and construction location is provided in Table 11.2.5-5. The emissions of air contaminants for the Construction, including activity at and within the Strait of Belle Isle, emissions from blasting, and construction equipment, are presented in Table 11.2.5-7.

Table 11.2.5-7 Air Contaminant Emissions – Construction

Air Contaminant	Year 1 (t/y)[a]	Year 2 (t/y)	Year 3 (t/y)	Year 4 (t/y)	Year 5[b] (t/y)	Total (tonnes)
Sulphur dioxide	37.1	81.8	136	235	10.2	500
Nitrogen oxides	564	1,244	1,665	2,302	155	5,931
Carbon monoxide	123	268	364	513	33.4	1,301
Volatile organic compounds	46.0	102	116	125	12.7	401
Total PAHs	0.02	0.05	0.05	0.04	0.01	0.16
Particulate matter	39.6	87.5	101	112	10.9	351
PM_{10}	39.6	87.5	101	112	10.9	351
$PM_{2.5}$	39.6	87.5	101	112	10.9	351

(a) t/y = tonnes / year.
(b) Construction will occur over four years in total, from year one to year five of the Project.

Fugitive Dust

Fugitive dust is particulate matter that originates primarily from the movement of mobile equipment on unpaved surfaces, or wind on aggregate storage piles, especially during dry and windy periods. There is potential for fugitive dust to be generated during several Construction activities. Note that emissions from concrete production for the Project are expected to be low in magnitude due to the small quantities of concrete required and are thus not considered further.

Construction activities include site preparation (e.g., clearing, grubbing, blasting), excavation, and earth-moving activities. The activities are transient in nature (both in time and space), and resulting dust levels are dependent on several factors such as moisture in the soil, the location and terrain, the level of activity at a particular location and meteorological conditions at the time. Any potential for dust generation would likely occur during periods of high winds or extreme dry periods, on areas with exposed soil and / or gravel (e.g., gravel roads, converter station sites).

Fugitive dust emissions will be controlled by use of best practices that include limiting the extent of clearing (i.e., limited disturbance of soil and vegetation roots). These measures were described above, and will be reflected in the EPP for the Construction phase.

In addition, the distribution of heavy equipment use in space and in time during Construction would result in sufficient dispersion of these air contaminants (total suspended particulates including fugitive dust). Considering the use of proven construction methods and effective mitigation, episodes of high dust concentrations are expected to be site-specific, of low frequency and short duration.

Emissions from a Project-induced fire (i.e., small contained fire, small brush fire) would include particulate matter (smoke) and combustion gases. Fire may be caused as a result of Construction activities (e.g., hot equipment). Interactions may thus occur with a change in air quality. While the emissions are likely to be substantively during the short-term event, with the planned mitigation (such as routine maintenance on equipment to prevent overheating and electrical issues that could cause fires, proper handling of flammable materials, designated smoking areas, good housekeeping practices, fire suppression systems and incident response plans), substantive fires are considered unlikely to occur and any fire is expected to be of low magnitude and short in duration. Thus, air contaminant emissions from a fire are unlikely to cause ambient air quality to frequently exceed the regulatory standards. The changes resulting from a Project-induced fire are therefore unlikely to measurably influence long-term ambient conditions.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Air Quality are as follows:

- Adverse, because construction activities will result in air contaminant emissions (PM, PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, total VOCs, and total PAHs);
- Of low magnitude, because ambient concentrations of air contaminants are expected to increase near construction activities, but are expected to be below ambient objectives, guidelines or standards;
- Regional, because it will be limited to the RSA; and
- Of short-term duration, because air contaminants will quickly disperse once released from equipment and activities associated with Construction.

The mitigation measures to reduce environmental effects of the Project on Air Quality will be implemented wherever technically and economically feasible to minimize adverse environmental effects. Given the likely low magnitude of these releases to the atmosphere, the low frequency of occurrence, limited duration of activity at any one location, and the mitigation that will be applied, the releases of air contaminants from Construction are not likely to cause the regulatory standards to be frequently exceeded.

There is a high degree of confidence that the level of effect will not be greater than that predicted due to the conservative assumptions made for fuel estimates, duration of equipment of operation and the scientific certainty in the emission factors used (IPCC 2006a, b).

11.2.5.5 Construction Effects: Sound

The Construction of the Project will contribute to ambient sound levels through the noise generated by the activities outlined in Table 11.2.3-3. Following the methodology described above for decision-making on detailed analyses, there are a number of construction activities that, due to their nature and / or location, were not considered of sufficient concern to require further modelling and assessment. These include:

- The construction of access trails and roads – access roads will be developed from existing roads to select points along the final ROW. In addition to these, a construction access trail is required along the length of the final ROW to provide safe travel conditions for crews. Conventional construction techniques will be used, resulting in localized noise for finite time periods. As these effects are well known and familiar to the public and regulators, and are located in remote areas, this potential interaction is not assessed further. Borrow material will be required to construct roads and trails. These activities are well-understood by the public due to their familiarity with the construction of public roads. As these areas of activity are localized in time and space, and sound pressure levels are low in magnitude, no further assessment was conducted.
- Clearing and preparation of the ROW, where necessary – this activity will be accomplished by conventional means, using diesel powered vehicles including mechanical harvesters, and crews with chainsaws, to clear and salvage woody vegetation. These activities will be conducted in accordance with standard utility practices and procedures. All cleared materials (including salvaged timber, brush and debris), within 6 m from both sides of the access trail within the eventual ROW will be windrowed along the edge of the ROW to allow safe vehicle passage. These activities will generate essentially the same level of noise as timber harvesting and clearing for public roads. The activities and associated noise levels are understood, and localized in both space and time at any point within the LSA. An increase in noise levels is likely to be perceptible (more than 3 dBA increase) for a period of approximately three to four days, but not likely to exceed the Health Canada criteria (Health Canada 2009) and are therefore not assessed further.
- The movement of materials – this activity will be accomplished by tracked vehicles, such as a nodwell, or small tractors. Helicopters may be used if required, depending on the terrain and site-specific conditions. At any location where noise may be detected, these activities will be infrequent and of short duration. While the noise level may be elevated for a short time, it is not likely to exceed the ambient noise guidelines described by Health Canada (2009). The associated sound emissions released from the operation of this equipment will be minimal, limited in volume, and will move as the construction locus moves along the ROW and are therefore not further assessed.
- Temporary construction camps – these camps, strategically located along the length of the corridor, will house workers and will be managed to ensure that workers are rested and healthy. Sound pressure levels within the camps will be governed accordingly, and only limited sounds would escape the camp boundaries. These effects are therefore not assessed further.
- Movement of materials from marshalling yards and staging areas – trucks and cranes will be used to deposit and retrieve materials from marshalling yards and staging areas. By locating these away from human settlements, the environmental effects will be low in magnitude, and are therefore not assessed further.
- Stringing the conductor – the final stage in the transmission line construction is stringing the conductor and attaching it to the towers. The conductor will be rolled onto the ROW using pulleys and specialized crews will attach the conductor to the towers. This activity will be of shorter duration, and will use fewer pieces of equipment, than tower erection. Standard mitigation will maintain sound pressure levels within ambient noise guidelines described by Health Canada (2009) (Section 11.2.5.1).

- Construction of converter stations – the facilities at the converter stations will be relatively small buildings, as described in the Project Description. Sound emissions will be typical of construction of these types of buildings including small substations, service stations, or commercial outlets. Blasting may also be required during the construction of the converter station. The sound emissions will be localized, short in duration and will be limited by the application of standard mitigation (Section 11.2.5.1).
- Installation of the electrodes – this activity will involve site clearing, excavation and building construction, and these activities will occur near L'Anse au Diable in Labrador and Dowden's Point in Conception Bay in Newfoundland. Both electrode sites are located in rural settings and the construction will be of medium duration and localized, and therefore, the environmental effects are likely to be negligible, and are not assessed further.

Other construction activities are considered of sufficient concern to warrant modelling to inform the assessment. These are as follows:

- The assembly and installation of the towers – this activity will involve the excavation of material at each tower location, which will involve blasting at locations, tower assembly and erection. These work activities will be accomplished using heavy-duty diesel equipment over a period of approximately four days per tower. This is the most intensive sound-producing activity because of the multiple pieces of equipment involved and the length of time the equipment will be working at any one location.
- Preparation and construction of submarine cable landing sites and the construction and installation of the submarine cables – these activities have the potential to generate noise that could affect the nearby communities along the coasts of Labrador and Newfoundland and are therefore further assessed.

Assembly and Installation of Towers

The assembly and installation of the towers has the greatest potential to generate noise due to the amount of construction equipment operating at any given time at a specific location, including blasting. The final locations of the towers within the LSA will be established according to topographic, meteorological and environmental conditions, and technical and engineering requirements. The ruling span between towers in normal loading zones is 300 to 430 m and in higher loading zones is 165 to 210 m. There will be approximately 910 to 1,305 towers installed between Muskrat Falls and the Strait of Belle Isle, of which more than 90% will be suspension-type structures, and another 1,880 to 2,630 towers between the Strait of Belle Isle and Soldiers Pond, of which approximately 90% will be suspension-type structures. The construction and installation of the towers will require four years to complete. As construction crews, equipment and activities will move along the ROW in a staged and sequenced manner, spending approximately four days at each tower location, the activity at a given location is temporary.

The sound pressure level outputs from typical construction equipment measured at a distance of 15 m, are presented in Table 11.2.5-8. Sound pressure levels of familiar noise sources have been included in Table 11.2.5-9 for comparison.

Table 11.2.5-8 Typical Construction Equipment Sound Pressure Levels

Construction Equipment and Activity	Sound Pressure Level (dBA at 15 m)
Roller	85
Front loader	80
Backhoe	80
Excavator	85
Bulldozer	85
Scraper, grader	85
Pick-up truck	55

Table 11.2.5-8 Typical Construction Equipment Sound Pressure Levels (continued)

Construction Equipment and Activity	Sound Pressure Level (dBA at 15 m)
Concrete mixer truck	85
Concrete pump truck	82
Crane	85
Pump	81
Generator	82
Generator (<25 kilovolt-amps (KVA))	70
Compressor (air)	80
Pneumatic tools	85
Jackhammer	89
Effect pile drivers (peak Levels)	101
Concrete saw	90
Chainsaw	84
Welder	74
Blasting	94
Drill rig[(a)]	104 (at 1 m)

Source: FHWA (2006).
[(a)] American Augers (n.d.), Performance Specifications.

Table 11.2.5-9 Sound Pressure Levels of Familiar Household Appliances

Familiar Noise Sources	Sound Pressure Level (dBA) at 1 m
Refrigerator	34 to 53
Hair clipper	50
Air conditioner	50 to 67
Hair dryer	58 to 64
Dishwasher	59 to71
Vacuum cleaner	65 to 80
Electric lawn mower	80 to 90

Source: ERCB (2007).

To predict the sound pressure levels resulting from the construction and installation of the towers, two predictive modelling scenarios were completed. The first scenario predicts the sound pressure levels resulting from blasting and the second scenario addresses the operation of typical construction equipment.

As described above, the majority of the towers installed will be the suspension type; and it is not known if blasting will be required at every tower location. Where blasting is required, a maximum of five blasts may be required depending on-site conditions. Each blast will use four to six sticks of explosives, all of which will be set off at the same time. For modelling purposes, resulting sound pressure levels were predicted based on setting off one blast since it is unlikely that more than one blast would occur simultaneously. The sound pressure level of 94 dBA was used in the modelling (Table 11-2.5-8). Through modelling it was determined that at approximately 23 m from the blast site sound pressure levels would reach 90 dBA and approximately 380 m away sound pressure levels would reach 65 dBA.

Based on input from engineering and consideration of the Project description, it was assumed that only three pieces of equipment would be operating at any given time, at 50% power output. For modelling purposes, the three pieces of equipment were assumed to be two excavators or harvesters and one crane. Nalcor will conduct construction activities in accordance with municipal by-laws regarding noise.

The background sound pressure levels, the maximum predicted sound pressure levels and the background plus predicted sound pressure levels during the day and night at each of the NSAs resulting from the use of cranes and excavators are presented in Table 11.2.5-10.

Table 11.2.5-10 Estimated Sound Pressure Levels during Assembly and Installation of Towers – Day and Night

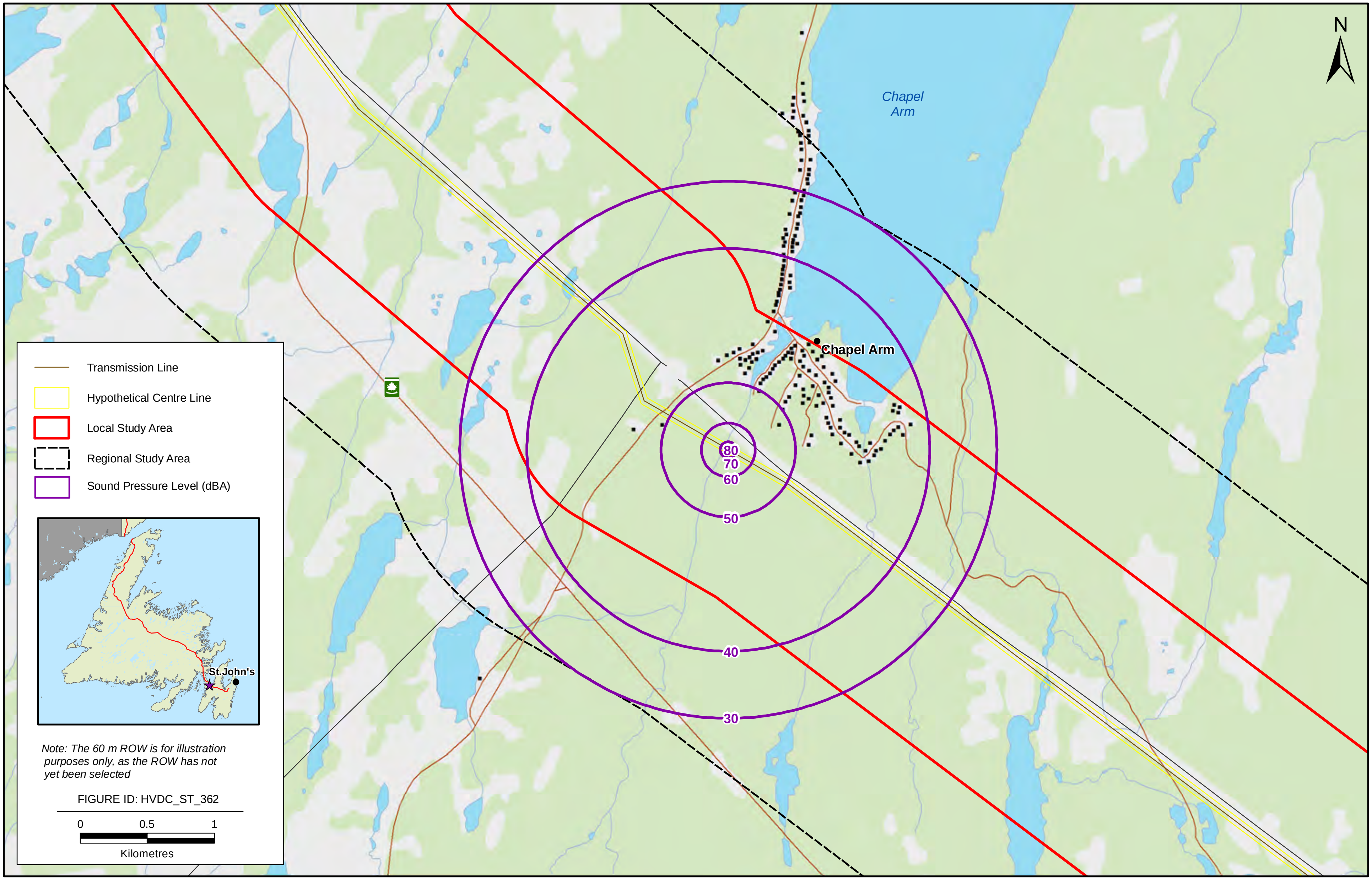
Noise Sensitive Area	Existing Background 1-hour L_{eq} (dBA)		Predicted 1-hour L_{eq} (dBA)		Background + Predicted 1-hour L_{eq} (dBA)			
	Day	Night	Day	Night[a]	Day	Night	L_{dn} (dBA)	% HA[b]
Forteau	45	35	42	—	47	35	46	1.30
Shoal Cove	45	35	55	—	55	35	53	3.22
Sandy Cove	45	35	55	—	55	35	53	3.22
Savage Cove	45	35	47	—	49	35	48	1.69
Mistaken Cove	45	35	47	—	49	35	48	1.69
Flower's Cove	45	35	42	—	47	35	46	1.30
Grand Falls-Windsor	50	40	43	—	51	40	51	2.49
Clarenville	50	40	43	—	51	40	51	2.49
Deep Bight	45	35	38	—	46	35	46	1.30
North West Brook-Ivany's Cove	45	35	42	—	47	35	46	1.30
Sunnyside	45	35	50	—	51	35	50	2.19
Chapel Arm	45	35	55	—	55	35	53	3.22
Whitbourne	45	35	55	—	55	35	53	3.22
Blaketown	45	35	55	—	55	35	53	3.22
Holyrood	45	35	55	—	55	35	53	3.22

[a] There are no predictions for nighttime construction noise as there will be no construction during the night. Local terrain data were not incorporated into the modelling.

[b] % HA = percent of the nearby population that would be highly annoyed.

The predicted sound pressure levels during tower installation for a representative segment along the LSA are presented in Figure 11.2.5-1. This is illustrative only because the final ROW alignment has not been determined.

As presented in Table 11.2.5-10, the L_{dn} value for the predicted construction noise plus background does not exceed 62 dBA (i.e., the Health Canada 2009 noise limit guideline) at any of the NSAs. The % HA for the predicted construction noise plus background ranges from 1.30% to 3.22%. Therefore, the change in % HA from the existing background noise, to background plus construction noise would not exceed the Health Canada criteria of 6.5%. The higher sound pressure levels generated during Construction will be transient as equipment moves along the ROW. Therefore, any nearby resident will not be affected for a prolonged period. Noise levels at NSAs during the night will also remain unchanged from the existing conditions, as site preparation, assembly and installation of towers will only occur during the day. If it is determined that there are locations of concern as designated by Health Canada (e.g., schools or places of worship) within the NSAs, mitigation will be applied as described above for Sound.



nalcor energy

FIGURE 11.2.5-1

Predicted Sound Pressure Levels at Chapel Arm during Construction (Tower Installation)

Preparation and Construction of Submarine Cable Landing Sites and Installation of Submarine Cables

The preparation and construction of submarine cable landing sites and the construction and installation of the submarine cables has the potential to generate noise that would be perceptible to nearby communities and / or residences. At both landing sites, HDD and trenching will be required. This will involve three, 1.5 to 2.5 km long drill paths in the Strait of Belle Isle and the actual distance will be confirmed during final Project design. Three boreholes will be drilled in sequence at each landing site (one per cable). Each borehole will consist of drilling a pilot bore and one or two additional reaming passes to achieve the desired diameter, followed by the installation of a liner. The equipment required to conduct this work will include land-based HDD rigs and associated equipment. One HDD rig is anticipated for each landing site, both of which will operate at the same time and drilling will occur 24 hours a day, seven days a week.

To predict corresponding sound pressure levels during the drilling at Forteau Point and Shoal Cove, predictive modelling was conducted using CadnaA and a typical drill rig with a sound power level of 115 dBA (as calculated from the sound pressure level of 104 dBA at 1 m (Table 11.2.5-8)). The predicted sound pressure levels at varying distances range from 42 dBA to 70 dBA (Table 11.2.5-11).

Table 11.2.5-11 Predicted Sound Pressure Levels with Distance from the Horizontal Directional Drill Rig

Distance from Drill Rig (m)	Sound Pressure Level (dBA)	Ldn		% HA		Change in % HA
		Baseline	Baseline + Predicted	Baseline	Baseline + Predicted	
50	70	45	76	1.14	42.2	41.1
100	64	45	70	1.14	24.9	23.8
200	57	45	63	1.14	11.6	10.5
300	54	45	60	1.14	8.1	7.0
400	51	45	57	1.14	5.6	4.5
500	49	45	55	1.14	4.4	3.3
1,000	42	45	48	1.14	1.8	0.7

Note: Health Canada Criteria for Construction lasting greater than one year = Change in % HA<6.5.

As shown in Table 11.2.5-11, residents located within 400 m of the drill rig will experience noise levels that would result in a change in % HA from background, to background plus construction noise that exceeds the Health Canada criteria of 6.5%.

Because of the location and duration of this activity, Nalcor will evaluate and apply the appropriate mitigation with respect to noise control. A noise attenuating berm may be constructed on-site if required, on the side of the activity facing residential receptors. If material is sufficient to break the line of sight, an attenuation of 5 dB is possible, and further addition of material to the berm could achieve an attenuation of 10 dB that would, in terms of human perception, reduce the audibility of the sound by half.

Cable laying and rock placement vessels will be used for the installation of the submarine cables and the protective rock berms. The locations of the ports or quarries to be used are not known at this time. The cable laying vessel will stay at sea once the laying begins, and be supplied by smaller vessels, limiting the noise generated at ports. The sequence of events for the rock placement vessel will consist of loading at port, sail to desired location, verify rock placement location, place rock, confirm rock placement via survey and sail back to port. Approximately 55 trips will be required. This is a limited number of trips given the duration of the Construction phase, but rock handling (i.e., during loading at port) can create noise. Construction activities will comply with municipal by-laws regarding noise.

After the incorporation of mitigation measures, the sound pressure levels during Construction at the NSAs are likely to cause only brief annoyance during periods of particularly intensive activity. Further, considering Nalcor's proposed mitigation, it is not likely that Health Canada criteria will be frequently exceeded.

Fire may be caused as a result of construction (e.g., hot equipment). Sirens from emergency vehicles and the fire itself could cause temporary increases in sound pressure levels. The changes to noise resulting from a Project-induced fire are therefore likely to be negligible.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Sound are as follows:

- Adverse, because there will be an increase in sound pressure levels that is undesirable.
- Low in magnitude because the increase in sound pressure levels will be below noise guideline levels.
- Limited to the RSA.
- Of short-term to medium-term duration depending on the activity. The noise will be short-term during construction at individual tower locations, but medium-term at the locations of the HDD rigs and the construction of the converter stations.

Given the likely low magnitude of the noise emissions, the low frequency of occurrence, limited duration of occurrence and the proposed mitigation, noise from Construction is not likely to cause the regulatory standards to be frequently exceeded.

With respect to the sound assessment, there is a high degree of confidence for the prediction of sound pressure levels by mathematical modelling. The uncertainties derive from the differences in surface type, vegetative cover and the differences in equipment sound pressure output from those assumed in the modelling. The combined uncertainty is likely to be less than 5 dB. Background levels are variable in remote areas due to the variation of weather-induced and wildlife sounds. Background sound levels near human settlements are likely higher, offering a greater degree of masking of the Project-related sounds. Overall, these uncertainties are small and do not affect the overall level of confidence.

11.2.6 Operations and Maintenance

11.2.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

During Operations and Maintenance of the Project, the effects on the Atmospheric Environment will result primarily from the use of helicopters, motor vehicles and light equipment (e.g., chainsaws, ATVs). The burning of fossil fuels will release air contaminants and GHGs, as well as contribute to elevated sound pressure levels within the LSA.

The activities during Operations and Maintenance that are relevant to Atmospheric Environment are:

- operating vehicles on access trails and roads, routine line inspections and repairs, and vegetation management which may require the use of tracked vehicles, trucks, ATVs, chainsaws, and helicopters; and
- presence and operation of the transmission system that may generate coronal noise.

Similar to Construction, the federal guidance (CEA Agency 2003, internet site) was followed in the assessment of Climate (GHG emissions).

Mitigation proposed by Nalcor during Operations and Maintenance activities that are relevant to Climate and Air Quality include:

- Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task.
- Vehicles and equipment will comply with the relevant federal vehicle emissions and energy efficiency standards that are applicable at that time.
- Well maintained equipment with quality mufflers will be used. Equipment maintenance schedules will be followed.
- Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic.
- Dust issues will be addressed on a case by case basis and mitigation (e.g., dust control) will be considered locally as appropriate.

Increases in noise during Operations and Maintenance will emanate from the power lines due to coronal discharge (i.e., the noise generated by a power transmission line carrying a current). Mitigation of noise from coronal discharge includes avoidance of sensitive receptors during the final ROW alignment selection. In addition, the selection of the voltage level and conductor size will be such that the audible noise is in compliance with the US EPA's (1974) regulations, as there are currently no Canadian noise control regulations applicable to High Voltage direct current (HVdc) transmission lines.

11.2.6.2 Existing Knowledge

Through previous experience of the Study Team (Stantec 2010b; Jacques Whitford 2009; Jacques Whitford 2006) and a review of relevant literature, summaries of existing knowledge on the effects of the operations and maintenance of similar projects on the Atmospheric Environment are presented for Climate (Table 11.2.6-1), Air Quality (Table 11.2.6-2) and Sound (Table 11.2.6-3).

Table 11.2.6-1 Existing Knowledge (Operations and Maintenance): Environmental Effects of Similar Projects on Atmospheric Environment (Climate - Greenhouse Gas Emissions)

Reference	Study / Project Context	Summary of Findings
Argonne National Laboratory (2007, internet site)	Design, construction, and operation of long-distance high-voltage electricity transmission technologies	During operation of an HVdc system, periodic line inspections (by ground or air) and vegetation management activities will require the combustion of fuel
IPCC (2006b)	GHG emissions from fuel combustion	The combustion of fossil fuels will result in emissions of GHGs, principally CO_2
Natural Resources Canada (NRCan) (2011, internet site); Farmers Weekly Interactive (2008, internet site); The Climate Registry (TCR) 2008; Universal Helicopters Newfoundland Ltd. (2003, internet site)	Vehicle specifications	Fuel economy or consumption rates were obtained for an ATV, helicopter, light duty gasoline truck (Ford F-150), and large diesel trucks
US EPA (2005)	Chainsaw information	Information obtained includes typical horsepower, brake-specific fuel consumption, and CO_2 emission factor. CH_4 and N_2O emission factors were not available
TCR (2011, internet site)	GHG emission factors	GHG emission factors for gasoline, diesel, and turbo fuel (aviation) vehicles

Table 11.2.6-2 Existing Knowledge (Operations and Maintenance): Environmental Effects of Similar Projects on Atmospheric Environment (Air Quality)

Reference	Study / Project Context	Summary of Findings
European Environment Agency (EEA) (2010a, b)	Aviation and road vehicle exhaust	Information obtained includes air contaminant emission factors for helicopters, light duty gasoline trucks, and heavy duty diesel trucks
Argonne National Laboratory (2007, internet site)	Design, construction, and operation of long-distance high-voltage electricity transmission technologies	During operation of an HVdc system, periodic line inspections (by ground or air) and vegetation management activities will require the combustion of fuel
US EPA (2005)	Chainsaw	Information obtained includes typical horsepower, brake-specific fuel consumption, and air contaminant emission factors

Table 11.2.6-3 Existing Knowledge (Operations and Maintenance): Environmental Effects of Similar Projects on Atmospheric Environment (Sound)

Reference	Study / Project Context	Summary of Findings
Georgia Transmission Corporation (2008b)	Transmission line EAs from Canada, North America and globally	– Coronal discharge sounds can approach levels of 60 dBA near the transmission lines. – Helicopter passes could approach 60 dBA at ground level, but the approaching sound is gradual, rather than sudden and startling, and is also infrequent. – Once constructed and placed in service, the transmission line would not be a significant long-term noise source in any areas adjacent to the ROW.
Argonne National Laboratory (2007, internet site)	Design, construction, and operation of long-distance high-voltage electricity transmission technologies	– During operation of an HVdc system, the main source of noise is the converter transformers, which can be surrounded by screens to attenuate the noise.
Public Service Commission of Wisconsin (n.d., internet site)	Environmental Impacts of Transmission Lines	– During operation of a High Voltage transmission line, noise in the form of sizzles, crackles, or hissing may be experienced. This effect is very weather dependent. The noise quickly dissipates with distance and is easily overshadowed by typical background sounds.

11.2.6.3 Operations and Maintenance Effects: Climate

The activity level during Operations and Maintenance related to releases of GHGs is low and negligible (i.e., limited to small trucks, tracked vehicles, equipment use and the proportional fossil fuel combustion). These activities include the following: inspection, maintenance, repairs along the ROW and at other Project components; vegetation management; site waste management; and the maintenance of access roads.

The GHG emissions were conservatively estimated using available Project information based on input from Project engineers and the Project description, published emission factors (TCR 2011, internet site; US EPA

2005), and information from publically available sources (Table 11.2.6-1). The assumptions made in calculating the estimate include:

- inspection and maintenance activities are conducted four times per year, including an annual inspection of the entire transmission line and an additional 10% being inspected via climb-inspection;
- there are six centres from which inspection and maintenance activities are deployed, such that vehicles and equipment travel 400 km round-trip during activities; and
- vegetative management is not expected to remove quantities of timber or other vegetation to noticeably change the carbon sequestration capabilities following Construction.

Further, the equipment used to conduct inspections and maintenance consists of the following:

- Two large diesel trucks, each with a fuel economy of 2.5 kilometres per litre (km/L) (5.8 miles per U.S. gallon) (TCR 2008).
- Five gasoline ATVs, represented by the Honda Foreman S model with a fuel economy of 13.7 km/L (32.1 miles per gallon) (Farmers Weekly Interactive 2008, internet site).
- One helicopter (burns turbo fuel), represented by a Bell Helicopter Textron 407. This model has a cruising fuel consumption rate of 190 litres per hour (L/hr) and a cruising speed of 266 kilometres per hour (km/hr) (165 miles per hour) (Universal Helicopters Newfoundland Ltd. 2003, internet site).
- One light duty gasoline truck, represented as a 2005 Ford F-150 truck. The fuel economy of the truck is 12.9 L/100 km (7.75 km/L) (NRCan 2011, internet site).
- Ten gasoline chainsaws. Each chainsaw is assumed to have a six horsepower engine, and operates six hours per inspection / maintenance period (US EPA 2005).

On this basis, the GHG emissions from Operations and Maintenance are estimated to be 60,120 tonnes CO_2e per year.

Emissions from a Project-induced fire (i.e., small contained fire, small brush fire) could include GHGs. Fire may be caused as a result of operations (e.g., hot exhaust systems in contact with roadside vegetation), and maintenance (e.g., hot equipment). Interactions may thus occur with a change in GHG emissions.

While the emissions due to fire are likely to be measurable during the short-term event, with the planned mitigation (such as routine maintenance on equipment to prevent overheating, and electrical issues that could cause fires, proper handling of flammable materials, good housekeeping practices, fire suppression systems and incident response plans), substantive fires are considered unlikely to occur and any fire is expected to be of low magnitude and short in duration. The changes resulting from a Project-induced fire are therefore unlikely to noticeably influence long-term ambient conditions.

Nalcor's proposed mitigation measures to reduce environmental effects of Project Operations and Maintenance on the Climate KI (GHG emissions) will be implemented wherever technically and economically feasible. Based on the emission estimates and the proposed mitigation, the magnitude of these GHG emissions is low in context of the CEA Agency guidance (2003).

Considering Nalcor's proposed mitigation, the effects of Project Operations and Maintenance on Climate are likely to be as follows:

- adverse, because of the release of GHGs;
- low in magnitude, because the quantities of the GHG releases are low;
- beyond regional (i.e., global) in geographic extent; and

- of long-term to far future duration, because of the long timeframe that GHGs can persist in the atmosphere.

Given the likely low magnitude, the low frequency of occurrence, and the mitigation that will be applied, the GHG emissions from Operations and Maintenance are likely to be low, in the CEAA (2003) context.

There is a high degree of confidence in the prediction of GHG emissions associated with Operations and Maintenance activities of the Project due to the conservative assumptions made for fuel estimates and the scientific certainty in the emission factors used (IPCC 2006a, b).

11.2.6.4 Operations and Maintenance Effects: Air Quality

The release of air contaminants to the atmosphere during Operations and Maintenance activities is expected to originate primarily from vehicle and equipment use, including during vegetation management along the ROW. Similar to the estimate for GHGs, air contaminant emission estimates have been made on the basis of expected number of kilometres travelled and associated fuel consumption.

The estimated releases of air contaminants are provided in Table 11.2.6-4.

Table 11.2.6-4 Estimated Emissions of Air Contaminants – Operations and Maintenance

Air Contaminant	Emissions (tonnes / year)
SO_2	1.3
CO	2,960
NO_X	293
PM	76

Source: EEA (2010a, b); ExxonMobil (2008); US EPA (2005); US EPA (1985, internet site).

The mitigation measures to reduce environmental effects of Project Operations and Maintenance on Air Quality were provided in the effects management discussion and will be implemented wherever technically and economically feasible.

The chlorine gas emitted at the anode will be dissolved in the water and form secondary and tertiary products, a small quantity of which could escape to the environment depending on the conditions. Any gas escaping to the air would be dispersed efficiently by the wind and chlorine concentrations are likely to be negligible (i.e., below 0.4 ppm) (Canadian Centre for Occupational Health and Safety 2011, internet site). As a result, chlorine gas is not considered further in the assessment.

Emissions from a Project-induced fire (i.e., small contained fire, small brush fire) would include particulate matter (smoke) and combustion gases. Fire may be caused as a result of operations (e.g., hot exhaust systems in contact with roadside vegetation), and maintenance (e.g., hot equipment). Interactions may occur, resulting in a change in Air Quality.

While the emissions are likely to be measurable during the short-term event, with the planned mitigation (such as routine maintenance on equipment to prevent overheating, and electrical issues that could cause fires, proper handling of flammable materials, fire suppression systems and incident response plans), substantive fires are considered unlikely to occur and any fire is expected to be of low magnitude and short in duration. Thus, air contaminant emissions from a fire is unlikely to cause ambient air quality to frequently exceed the regulatory standards. The changes resulting from a Project-induced fire are therefore unlikely to influence long-term ambient conditions.

Considering Nalcor's proposed mitigation, the effects of Project Operations and Maintenance on Air Quality will likely be as follows:

- Adverse, because of the release of air contaminants that is undesirable;
- Low in magnitude, because the quantities of the releases are small, and not likely to cause the ambient concentrations to exceed the ambient objectives, guidelines, and standards;
- Limited to the LSA; and
- Of short-term duration, lasting only as long as any maintenance trip to a specific location, expected to typically last a few days.

Given the likely low magnitude and dispersed locations of these releases to the atmosphere, the low frequency of occurrence, limited duration of occurrence and the mitigation that will be applied, emissions from Operations and Maintenance are not likely to cause the regulatory standards to be frequently exceeded.

There is a high degree of confidence that the level of effect will not be greater than that predicted due to the conservative assumptions made for fuel estimates and the scientific certainty in the emission factors used (IPCC 2006a, b).

11.2.6.5 Operations and Maintenance Effects: Sound

Operations and maintenance of the Project has the potential to result in an increase in ambient sound levels and therefore affect the Atmospheric Environment during the activities outlined in Table 11.2.3-3.

Sound emissions from ventilation of buildings, such as the converter stations, are localized and likely to be low (Section 11.2.4 and Table 11.2.6-3). The noise emitted during routine line inspections and repairs (e.g., engine noise from ATVs and helicopters), vegetation management, use of access roads, and potential major system repairs (e.g., post storm event) will be similar to noise levels predicted from the use of equipment during Construction of the Project.

Every year, Nalcor will conduct line inspections via helicopter and / or ground patrol. The use of a helicopter to inspect long transmission lines is a cost-effective alternative to ground-based inspections. Assuming these inspections are 100% conducted via helicopter, the helicopters would travel quickly (approximately 200 km/h) along the ROW at an altitude of 100 m, and therefore spending less than one minute over any one location along the ROW. Takeoffs and landings are not likely to occur on the ROW. The sound pressure levels would be higher (85 dBA) than a ground vehicle moving along a trail down the centre of the ROW, but would last only a short time. In addition to the helicopter inspections, Nalcor will thoroughly inspect approximately 10% of the line each year, which will include a tower and conductor inspection, via land based equipment such as ATVs.

The noise pressure levels associated with the activities described above are likely to be low and below the Health Canada (2009) criteria, and primarily in remote areas. Therefore, the noise from these activities, and the potential effects, are not considered further in the assessment.

Of the activities described in Table 11.2.3-3, noise associated with the presence and operation of the transmission system has the potential to cause an adverse effect on the Sound KI.

The noise generated by a power transmission line carrying a current is referred to as coronal discharge noise. Corona refers to the partial breakdown of air at highly stressed points on the surface of a conductor and the resulting sound is audible noise. The coronal discharge sound from direct current (dc) lines is lower than that from alternating current (ac) lines. This is a reflection of the fact that the dc lines are more efficient, and therefore dissipate less energy in coronal discharge, than alternating current (ac) lines. The discharge exhibits as a crackling or buzzing, and is dependent on weather conditions. The noise from ac lines, which is more common than dc lines, has a tonal spectrum reflective of a frequency of 120 Hertz (Hz). The noise from dc lines will be less tonal. Sound that is not tonal is less annoying than those that are tonal (Canadian Standards Association 2005).

There are currently no Canadian noise control regulations applicable to HVdc transmission lines. The US EPA's (1974) "levels document" proposed a day-night average ($L_{dn,\ 50\%}$) noise limit of 55 dBA based on which several regulating bodies have developed regulations for transmission line applications. The calculated average audible noise should be limited to 42 dBA. Nalcor has based its selection of the voltage level and conductor size on this limit.

The % HA associated with coronal discharge from the Nalcor HVdc transmission line at the edge of the ROW, was calculated to be less than 3%, which is less than the Health Canada (2009) criteria of 6.5%.

For relatively steady sounds, L_{50} may approximate L_{eq}, but even allowing for any reasonable differences, the sound of coronal discharge would be below the Health Canada criteria (Health Canada 2009). Indoor levels would be at least 10 dB and likely 15 to 20 dB lower than the outdoor levels. Therefore, speech interference resulting from the coronal discharge noise, for people talking within structures in the immediate vicinity of the ROW is not likely. Outdoors, the levels will likely be perceptible, and comparable to background levels at the edge of the ROW, diminishing to imperceptibility within the LSA.

Fire may be caused as a result of Operations (e.g., hot exhaust systems in contact with roadside vegetation), and Maintenance (e.g., hot equipment). Sirens from emergency vehicles and the fire itself could cause temporary increases in sound pressure levels. Interactions may thus occur with a change in sound quality. The changes resulting from a Project-induced fire are therefore unlikely to influence long-term ambient conditions.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on Sound are as follows:

- Adverse, because there will be an increase in sound pressure levels that is undesirable;
- Low in magnitude, because the increase in sound pressure levels will be within the normal range of variability and the accepted guideline of 42 dBA (US EPA) will be adhered to;
- Limited to the LSA; and
- Far-future duration because the noise generated by the Project would extend through the life of the Project.

Given the likely low magnitude of the noise emissions, noise from Operations and Maintenance is not likely to cause the regulatory standards to be exceeded. There is a high degree of confidence that the level of effect will not be greater than that predicted due to the conservative assumptions made for noise estimates and the scientific certainty in the engineering design and expected coronal discharge.

11.2.7 Environmental Effects Summary and Evaluation of Significance

11.2.7.1 Summary of Environmental Effects

The environmental effects on Atmospheric Environment during Construction, and Operations and Maintenance are summarized for Climate (GHG emissions), Air Quality and Sound.

Climate (GHG emissions)

The likely environmental effects on Climate (GHG emissions) were analyzed for this Project by conducting a preliminary scoping of GHG emissions, and considering the magnitude, intensity and timing of Project emissions. Specifically, the quantities of GHG emissions resulting from the Project were estimated and the relative amounts compared to provincial, national and global GHG emissions, and to the qualitative categories of low, medium and high as described in the CEA Agency (2003) guidance.

The majority of the GHG emissions from the Project will be released during Construction. Over the four-year construction period, an estimated 660,953 tonnes CO_2e will be released (including loss of carbon sequestration and biomass carbon associated with clearing of trees). The maximum GHG emissions in any one year of

Construction will be approximately 204,904 tonnes CO_2e. As such, the maximum yearly GHG emissions during Project Construction will represent approximately 3.6% of the province's annual GHG emissions, 0.07% of Canada's annual GHG emissions, and <0.05% of global emissions (Section 11.2.5.3, Construction Effects: Climate (GHG emissions)).

The GHG emissions from Operations and Maintenance were conservatively estimated to be 60,120 tonnes CO_2e per year. This is considerably lower than that for Construction activities on an annual basis. In context of the emissions from the province, Canada and globally, the fractions remain small.

The GHG emissions from the Construction, and Operations and Maintenance of the Project are considered low in the context of CEA Agency guidelines (Section 11.2.4.1).

Air Quality

The Project has the potential to temporarily increase the ambient concentrations of air contaminants in the RSA during Construction. However, it is not expected that the regulatory ambient standards will be frequently exceeded during construction. The effects of the Project-related activities on Air Quality during construction are likely to be adverse, of low magnitude, limited to the RSA, and of short-term duration (Section 11.2.5.4).

The Project also has the potential to increase the ambient concentrations of air contaminants in the LSA during Operations and Maintenance However, it is not likely that the regulatory ambient standards will be frequently exceeded. The effects of the Project-related activities on Air Quality during Operations and Maintenance are predicted to be likely, of low magnitude, limited to the LSA, and of short-term duration (Section 11.2.6.4).

The releases of air contaminants from the Construction, and Operations and Maintenance of the Project are likely to be negligible and will not noticeably influence ambient Air Quality outside the LSA.

Sound

It is likely that the effects on Sound during Construction will be intermittent. The effects on Sound during Operations and Maintenance will be negligible for coronal discharge and shoreline electrodes.

The effects of the Project-related activities on Sound during Construction are likely to be adverse, of low magnitude, limited to the RSA, and of short-term duration (Section 11.2.5.5).

The effects of the Project-related activities on Sound during Operations and Maintenance are likely to be adverse, of low magnitude, limited to the LSA, and for the far future in duration (Section 11.2.6.5).

A summary of Project effects on the Atmospheric Environment is presented in Table 11.2.7-1.

Table 11.2.7-1 Environmental Effects Analysis Summary: Atmospheric Environment

Project Phase / Key Indicator	**Likely Residual Environmental Effects Summary Descriptors**				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Climate (GHG)	**Adverse** – Activities will result in GHG emissions	**Low** – The quantities of GHG releases are low	**Beyond Regional** – Climate (GHG) effects are global in nature	**Long-term to Far Future** – GHG emissions can persist in the atmosphere for several hundred years	– Emissions of GHGs will occur during construction activities throughout the Construction of the Project
Air Quality	**Adverse** – Activities will result in air contaminant emissions	**Low** – Ambient concentrations of air contaminants will likely be below ambient objectives, guidelines or standards	**Regional** – Concentrations of air contaminants are likely to be back to ambient levels within 1 km of construction sites on either side of the LSA	**Short-term** – Air contaminants will quickly disperse from construction sites	– Concentrations of air contaminants will not likely frequently exceed ambient standards at any one location throughout the construction phase
Sound	**Adverse** – Activities will increase sound pressure levels	**Low** – The increase in sound pressure levels will likely be well below guidelines applied to the Project	**Regional** – Sound pressure levels will likely return to ambient levels within 1 km of construction sites on either side of the LSA	**Short-term to Medium-term** – Sound will only be generated during Construction activities (daytime, Monday through Saturday); the HDD rigs will operate for up to 2.5 years	– Sound emissions are expected periodically at any one location throughout the Construction phase
Summary of Likely Residual Construction Effects on Atmospheric Environment: Project effects on the Atmospheric Environment are predicted to be limited to contaminant emissions and noise primarily resulting from the operation of equipment and isolated blasting. These effects are expected to dissipate quickly and extend only a limited distance (i.e., less than 1 km) from the work area. The quantities of GHGs released to the atmosphere are likely to be low relative to provincial and national emissions, and are low in the CEA Agency 2003 context; changes to the concentration in the atmosphere are not likely to be substantive.					

Table 11.2.7-1 Environmental Effects Analysis Summary: Atmospheric Environment (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Operations and Maintenance					
Climate (GHG)	**Adverse** – Activities will result in GHG emissions	**Low** – The quantities of GHG releases are low	**Beyond Regional** – Climate (GHG) effects are global in nature	**Long-term to Far Future** – GHG emissions can persist in the atmosphere for several hundred years	– Emissions of GHGs will occur during periodic maintenance activities throughout the Project lifetime
Air Quality	**Adverse** – Activities will result in air contaminant emissions	**Low** – Ambient concentrations of air contaminants will likely be well below ambient objectives, guidelines or standards	**Local** – Emissions will be limited to the LSA, due to the limited level of activities associated with Operations and Maintenance (e.g., vegetation management)	**Short-term** – Air contaminants will quickly disperse from locations where maintenance work is occurring	– Emissions of air contaminants will occur during periodic maintenance activities throughout the Project lifetime
Sound	**Adverse** – An increase in sound pressure levels will result from coronal discharge and Operations and Maintenance activities	**Low** – The increase in sound pressure levels will likely be well below guidelines applied to the Project	**Local** – The increase in sound pressure levels will be limited to the LSA, as the activities are limited and the continuous noise (coronal discharge) is from the power line and dissipates within a short distance	**Far future** – Sound emissions are expected throughout Project Operations and Maintenance	– Coronal noise will be relatively constant (limited to within the ROW) throughout Operations and Maintenance – Maintenance activities will be infrequent (e.g., vegetation management will likely begin during year eight of Operations and repeated every seven years)

Table 11.2.7-1 Environmental Effects Analysis Summary: Atmospheric Environment (continued)

<table>
<tr><th rowspan="2">Project Phase / Key Indicator</th><th colspan="5">Likely Residual Environmental Effects Summary Descriptors</th></tr>
<tr><th>Direction</th><th>Magnitude</th><th>Geographic Extent</th><th>Duration</th><th>Frequency</th></tr>
<tr><td colspan="6">Summary of Likely Residual Operations and Maintenance Effects on Atmospheric Environment:
Within the LSA, Air Quality and Sound will likely be slightly affected at a location while activities are occurring and due to coronal discharge. Environmental effects are not likely to occur beyond the LSA. The quantities of GHGs released to the atmosphere are likely to be low relative to provincial and national emissions, and are low in the CEA Agency(2003) context; changes to the concentration in the atmosphere are not likely to be substantive.</td></tr>
</table>

11.2.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. A significant effect on the Atmospheric Environment VEC, by way of definition, could result from a significant effect on Climate (global), or Air Quality or Sound within the RSA, as discussed below.

A significant adverse residual environmental effect of the Project on Climate is one where the release of GHGs is of a quantity that is either medium or high, where those terms are used in the guidance provided by CEA Agency (2003). Since there is no clear quantitative threshold defined in the provincial or federal regulations, this qualitative definition is used to make the determination of significance.

The CEA Agency (2003, internet site) recommends that net changes in GHG emissions as a result of a project be evaluated and detailed mitigation be considered if they are found to be medium or high. As the Project is considered to be a low emitter of GHG in the CEA Agency (2003) context, detailed mitigation (beyond that of applicable regulations) is not required.

The residual Project-related quantities of GHGs released to the atmosphere are a small fraction of the provincial, national and global emissions, and are considered low, and not medium or high, in the context of the CEA Agency guidance (2003). Therefore, the likely environmental effects of the Project on Climate are rated not significant.

A significant residual effect on Air Quality is one that degrades the quality of the ambient air such that the Project-related ground-level concentrations of the air contaminant being assessed are likely to frequently exceed the regulatory ambient objective, guideline or standard. “Frequently” is defined as once per week for 1-hour objectives and once per month for 24-hour objectives. Given the planned mitigation measures and based on the consideration of magnitude, geographic extent and duration, the residual environmental effects of a change in Air Quality on the Atmospheric Environment in the RSA during Construction, and Operations and Maintenance of the Project are predicted to be not significant.

With respect to a change in Sound, a significant residual adverse environmental effect is one that causes a change in Sound such that a frequent exceedance of the Health Canada (2009) guidance (as presented in Table 11.2.4-2) is experienced at an NSA due to Project activities. “Frequent” is defined as an aggregate period of 12 days per year. Due to the planned mitigation measures and based on the consideration of magnitude, geographic extent and duration, the residual environmental effects of a change in Sound on Atmospheric Environment in the RSA during Construction, and Operations and Maintenance of the Project are predicted to be not significant.

The changes to the Atmospheric Environment resulting from the Project are unlikely to substantively influence ambient conditions within the RSA. Therefore, the Project is not likely to result in significant adverse effects on the Atmospheric Environment.

11.2.8 Evaluation of Project Alternatives

An evaluation for the environmental implications of the Project alternatives was completed for Climate, Air Quality and Sound (Table 11.2.8-1).

While there are some changes in the alignment associated with the Project alternatives, the differences are not enough to result in substantive changes in the releases of GHGs or ambient air quality. In one Project Alternative (A10), the distance to sensitive receptors is less, likely resulting in a slight increase in the effects on Sound.

Table 11.2.8-1 Summary Evaluation of Project Alternative Means: Atmospheric Environment

Project Alternative Means[a]	Environmental Implications (Compared to the Proposed Transmission Corridor)[b]		
	Climate	Air Quality	Sound
A2: North-west of Strait of Belle Isle Alternative Segment	A2 is slightly longer than the proposed transmission corridor. However, the difference in length is not sufficient to cause a substantive difference in the quantities of GHGs released	A2 is slightly longer than the proposed transmission corridor. However, the difference in length is not sufficient to cause a substantive change in ambient air quality	A2 is slightly longer than the proposed transmission corridor. However, the difference in length is not sufficient to cause a substantive difference in ambient sound levels
A3: Point Amour Alternative Segment	A3 is shorter than the proposed transmission corridor. The difference in length is not sufficient to cause a substantive change in the quantities of GHGs released	A3 is shorter than the proposed transmission corridor. However, the difference in length is not sufficient to cause a substantive change in ambient air quality	The population centres and distances to sensitive receptors affected by A3 and the proposed transmission corridor are similar; therefore, the effects on Sound are expected to be similar
A4: Strait of Belle Isle Newfoundland Side Alternative Segment	A4 is similar in length to the proposed transmission corridor. Therefore there is not likely to be a substantive difference in the quantities of GHGs released	A4 is similar in length to the proposed transmission corridor. Therefore there is not likely to be a substantive change in ambient air quality	The population centres and distances to sensitive receptors affected are similar; therefore, the effects on Sound are expected to be similar
A5: Great Northern Peninsula (GNP) North-east Alternative Segment	A5 is similar in length to the proposed transmission corridor. Therefore there is not likely to be a substantive difference in the quantities of GHGs released	A5 is similar in length to the proposed transmission corridor. Therefore there is not likely to be a substantive change in ambient air quality	The population centres and distances to sensitive receptors affected are similar; therefore, the effects on Sound are expected to be similar
A6: GNP West-central Alternative Segment	A6 is similar in length to the proposed transmission corridor. Therefore there is not likely to be a substantive difference in the quantities of GHGs released	A6 is similar in length to the proposed transmission corridor. Therefore there is not likely to be a substantive change in ambient air quality	The population centres and distances to sensitive receptors are slightly closer for A6 than for the proposed transmission corridor; the difference in distance is small and therefore the effects on Sound are expected to be similar
A7: GNP Eastern Long Range Mountain (LRM) Crossing Alternative Segment	A7 is similar in length to the proposed transmission corridor. Therefore, there is not likely to be a substantive difference in the quantities of GHGs released	A7 is similar in length to the proposed transmission corridor. Therefore, there is not likely to be a substantive change in ambient air quality	The population centres and sensitive receptors are further away for A7 than for the proposed transmission corridor; the difference in distance is small and therefore the effects on Sound are expected to be similar

Table 11.2.8-1 Summary Evaluation of Project Alternative Means: Atmospheric Environment (continued)

Project Alternative Means[a]	Environmental Implications (Compared to the Proposed Transmission Corridor)[b]		
	Climate	Air Quality	Sound
A7: GNP Eastern LRM Crossing Alternative Segment + A8: GNP International Appalachian Trail Newfoundland and Labrador Alternative Segment	A7 + A8 is similar in length to the proposed transmission corridor. Therefore, there is not likely to be a substantive difference in the quantities of GHGs released	A7 + A8 is similar in length to the proposed transmission corridor. Therefore, there is not likely to be a substantive change in ambient air quality	The population centres and sensitive receptors are further away for A7 + A8 than for the proposed transmission corridor; the difference in distance is small and therefore the effects on Sound are expected to be similar
A9: Birchy Lake Alternative Segment	A9 is slightly longer than the proposed transmission corridor. However, the difference in length is not sufficient to cause a substantive change in the quantities of GHGs released	A9 is slightly longer than the proposed transmission corridor. However, the difference in length is not sufficient to cause a substantive change in ambient air quality	The population centers and distances to sensitive receptors are slightly closer for A9 than for the proposed transmission corridor; the difference in distance is small and therefore the effects on Sound are expected to be similar
A10: Newfoundland and Labrador Outfitters Association Alternative Segment	A10 is longer than the proposed transmission corridor. The difference in length is not sufficient to cause a substantive change in the quantities of GHGs released	A10 is longer than the proposed transmission corridor. However, the difference in length is not sufficient to cause a substantive change in ambient air quality	The population centers and distances to sensitive receptors are closer for A10 than for the proposed transmission corridor; the difference in distance is sufficient to cause a slight increase in the effect on Sound
A11: Avalon Alternative Segment	A11 is similar in length to the proposed transmission corridor. Therefore, there is not likely to be a substantive difference in the quantities of GHGs released	A11 is similar in length to the proposed transmission corridor. Therefore, there is not likely to be a substantive change in ambient air quality	The population centers and sensitive receptors are slightly further away for A11 than for the proposed transmission corridor; the difference in distance is small and therefore the effects on Sound are expected to be similar.

[a] As identified and described in the EIS Project Rationale and Planning, Chapter 2.
[b] Namely, the proposed Project described in the EIS Project Description Chapter 3, and assessed in the preceding Environmental Effects Assessment.

11.2.9 Cumulative Environmental Effects

Cumulative effects are the overall effect on the VEC as a result of the Project's likely residual environmental effects that overlap both temporally and geographically with those of other projects and activities. A summary of the cumulative environmental effects associated with the Atmospheric Environment and other projects is provided in Table 11.2.9-1. As discussed in Section 11.2.2, likely environmental effects of the Project on the Atmospheric Environment were considered for the Project in its entirety instead of by region.

The future projects and activities considered for the cumulative effects assessment included those with likely overlapping environmental effects within the RSA. This included effects (e.g., noise and emissions to the atmosphere) resulting from the Lower Churchill Hydroelectric Generation Project, Trans-Labrador Highway Phase 3 operations, 5 Wing Goose Bay supersonic flight training, commercial forestry activity, and general economic and infrastructure development.

In relation to GHG emissions the CEAA guidance states:

> "*The EA process cannot consider the bulk of GHG emitted from already existing developments. Furthermore, unlike most project-related environmental effects, the contribution of an individual project to climate change cannot be measured*."

Nevertheless, the contributions of numerous sources of GHGs located around the globe are important in the context of climate change. In this case, however, the magnitude of Project-related GHG emissions is low, and, the Project is not expected to bring about a substantive change in Climate. As a result, the likely effects, including cumulative effects, of Project-related GHG emissions on Climate are rated as not significant.

Table 11.2.9-1 Cumulative Environmental Effects Summary: Atmospheric Environment

Cumulative Effects Analysis	Atmospheric Environment
Current (Baseline) VEC Condition (Reflecting the Effects of Past and Ongoing Projects and Activities)	**Climate** – Overall, the climate / GHG emissions of Newfoundland and Labrador are consistent across the province, with limited variation across the five regions from Labrador to the Avalon Peninsula. **Air Quality** – Ambient air quality in the regions is generally good, most of the time. On occasion, ambient ozone concentrations exceed the desirable National Ambient Air Quality Objectives (NAAQO); however, exceedances of the acceptable NAAQO are infrequent. Some industrial facilities are located in the regions near the Project. Emissions of air contaminants from these facilities range from 0.04% to 0.49% of Canada's total emissions. **Sound** – The ambient sound pressure levels along the length of the Project are representative of a rural environment with minimal contributing existing sound sources.

Table 11.2.9-1 Cumulative Environmental Effects Summary: Atmospheric Environment (continued)

Cumulative Effects Analysis	Atmospheric Environment
Likely Residual Environmental Effects of Labrador-Island Transmission Link (Reflecting Current VEC Condition, as Above)	**Climate** – The Project will generate approximately 660,953 tonnes Carbon dioxide equivalent (CO_2e) over the four year Construction period (including loss of carbon sequestration and biomass carbon associated with clearing of trees) with a maximum of 204,904 tonnes CO_2e in any one year. Project emissions are thus a small fraction of provincial and global emissions. – The Project's contribution to the residual change in GHG emissions is low (CEA Agency 2003, internet site), and because the environmental effect of the Project on climate change is not substantive, this contribution is considered to be not substantive. **Air Quality** – The Project will release emissions of air contaminants during Construction, and Operations and Maintenance activities, which will increase ambient concentrations of the air contaminants in the RSA when such activities are being undertaken. Upon cessation of those activities, the ambient air contaminant concentrations are expected to quickly return to background levels. **Sound** – The ambient sound pressure levels will increase at locations where Construction, and Operations and Maintenance activities are being undertaken. There are a few industrial facilities located near the RSA; however, the distance between the facilities and the LSA is sufficient that effects are not expected to noticeably influence ambient conditions, as the noise produced from the Project will be near background levels just outside the LSA (and within the RSA).
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	**Climate**[(a)] – Project-related GHG emissions are rated as not significant. The Project's contribution to the residual change in GHG emissions is very small relative to provincial and global emissions, and the cumulative environmental effect on climate change is not substantive. **Air Quality** – The future projects within 100 km of the Project have the potential to release emissions of air contaminants and result in a cumulative environmental effect on Air Quality. – The contributions of air contaminants from the potential future projects will not add to the emissions from the Project such that ambient conditions would change noticeably, because each of the potential future projects will be located outside the RSA. Emissions of air contaminants from the Project will disperse quickly from the LSA, and when combined with emissions from potential future projects, are unlikely to substantively influence ambient air quality and thus are unlikely to overlap. **Sound** – The contribution of sound from the future projects will not add substantively to the sound pressure levels from the Project, since they will be located outside the RSA. Sound pressure levels from the Project will disperse quickly from the LSA, and when combined with emissions from potential future projects, these are unlikely to cause the Health Canada (2009) criteria to be exceeded.

Table 11.2.9-1 Cumulative Environmental Effects Summary: Atmospheric Environment (continued)

Cumulative Effects Analysis	Atmospheric Environment
Cumulative Environmental Effects Summary	**Climate** – Not Significant ▪ As noted above, because of the low magnitude of the Project-related GHG emissions, the Project is not expected to bring about a substantive change in the environment. As a result, the cumulative environmental effects are rated not significant. **Air Quality** – Not Significant ▪ The cumulative environmental effects of the Project on Air Quality in combination with other projects and activities that have been or will be carried out are predicted to be not significant as they are unlikely to spatially overlap or substantively influence ambient air quality. **Sound** – Not Significant ▪ The cumulative environmental effects of the Project in combination with other projects and activities that have been or will be carried out are predicted to be not significant as they are unlikely to spatially overlap or substantively influence ambient sound pressure levels.

[a] Cumulative effects for climate are assessed at the global scale.

11.2.10 Monitoring and Follow-up

The Project activities are not different than other activities (e.g., forest harvesting, transportation, shipping) that currently occur within the LSA and RSA. Measurable effects to the Atmospheric Environment from the release of air contaminants from the combustion of fossil fuel and fugitive dust are expected to be localized to specific areas of activity during Construction, and Operations and Maintenance. A follow-up program to measure ambient air contaminant concentrations for the purpose of verifying the environmental effects predictions or the effectiveness of mitigation is not warranted.

Nalcor will employ a complaint driven process to address the generation of excessive airborne dust during any phase of the Project. Nalcor will ascertain the validity of the complaint and corrective actions will be implemented as warranted and appropriate. This could include conducting ambient measurements of dust, if required, to identify the source and / or extent of the issue and to identify appropriate mitigation measures.

11.3 Environmental Assessment Summary

This section presents a summary of the EA for the Atmospheric Environment. Subsections address the following:

- effects management measures planned for the Project to address identified issues;
- potential effects of moderate to high risk accidents and malfunctions and planned mitigation and response measures;
- predicted residual Project effects and their significance;
- cumulative environmental effects associated with the Project; and

- environmental monitoring and follow-up programs planned in relation to the Project.

11.3.1 Effects Management Measures

Table 11.3.1-1 and Table 11.3.1-2 provide a summary of the effects management measures that Nalcor has incorporated into the Project for Construction, and Operations and Maintenance, respectively. Nalcor is proposing to use best management practices and accepted, proven mitigation options to avoid or reduce the effects of the Project. Further, through their adaptive management process, Nalcor will assess issues that arise so that appropriate changes can be made to mitigation strategies or methods, and adopted in a timely manner.

Table 11.3.1-1 Construction Mitigation Strategies and Methods – Atmospheric Environment

KI	Proposed Mitigation
Climate and Air Quality	– Vehicles and equipment must comply with the relevant federal vehicle emissions and energy efficiency standards that are applicable at that time. – Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic. – Well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust. – Haul distances for construction material will be limited to the extent practical. – A complaint driven process will be used in relation to dust emissions and issues will be addressed on a case by case basis and corrective actions (e.g., dust control) implemented as warranted and appropriate. – Fire suppression mitigations such as routine maintenance on equipment to prevent overheating and electrical issues that could cause fires, proper handling and storage of fuels as per the EPP, fire suppression systems available as per the EPP.
Sound	– Construction activities will be conducted in accordance with municipal by-laws regarding noise. – High noise-producing construction equipment will be strategically placed as far away as practical from receptors. – All equipment will have appropriate mufflers and will be well maintained. – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP. – The size of explosive charges will be limited during blasting activities to the requirement of the blasting activity. – Sound barriers or berms will be used at the HDD sites, where practical, to minimize sound pressure levels leaving the sites. – Frequent and open communication will be conducted with nearby residents to identify and address any noise complaints. Complaints will be addressed on a case by case basis and mitigation options investigated and corrective action implemented as warranted and appropriate.

Table 11.3.1-2 Operations and Maintenance Mitigation Strategies and Methods – Atmospheric Environment

KI	Proposed Mitigation
Climate and Air Quality	– Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task. – Vehicles and equipment will comply with the relevant federal vehicle emissions and energy efficiency standards that are applicable at that time. – Well maintained equipment with quality mufflers will be used and equipment maintenance schedules will be followed. – Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic. – A complaint driven process will be used in relation to dust emissions; issues will be addressed on a case by case basis and corrective actions (e.g., dust control) implemented as warranted and appropriate. – Fire suppression mitigations such as routine maintenance on equipment to prevent overheating and electrical issues that could cause fires, proper handling and storage of fuels as per the EPP, fire suppression systems available as per the EPP.
Sound	– Completing any inspections, maintenance and / or repairs as quickly and efficiently as safety allows.

11.3.2 Accidents and Malfunctions

Chapter 5 identifies and describes potential incidents (i.e., accidents and malfunctions) related to Project Construction, and Operations and Maintenance. It also describes the potential environmental consequence (i.e., magnitude, extent, and duration) of these incidents and their probability of occurrence. The risk of each incident, a function of both probability of occurrence and environmental consequence, was then assessed as low, moderate or high.

Incidents that are considered to have low risk (i.e., have a low to high probability of occurrence, and a low consequence, such as small contained fires or small brush fires) are assessed above as part of the environmental effects assessment for the Atmospheric Environment VEC in this chapter. Incidents that are considered to separately have a moderate to high risk and have potential effects on the Atmospheric Environment are addressed in this section. Moderate to high risk incidents that may affect the Atmospheric Environment, potential effects of the incident, and prevention and response measures that will be implemented, are summarized in Table 11.3.2-1. Because they are unlikely to occur and effects management measures will be in place to address such incidents, the effects of moderate to high risk incidents are not likely to be significant.

Table 11.3.2-1 Summary of Potential Moderate to High Risk Incidents that Could Affect the Atmospheric Environment

Description of Incident	Likely Effects on the Atmospheric Environment	Prevention and Response Measures
Large forest fire in Labrador originating along the access roads or ROW, during the summer	Reduction in air quality through the release of particulate matter and carbon dioxide into the atmosphere	– Adherence to terms and conditions of Operating Permits issued by Forest Services Branch – The Safety, Health and Environment Emergency Response Plan (SHERP) will contain a fire prevention plan – The EPP will contain forest fire prevention measures and a fire response plan – Firefighting equipment will be available at each worksite – In the event of forest fire, immediate steps will be taken to extinguish fire (if safe to do so), and the fire will be reported to the provincial Forest Services Branch
Forest fire near a populated community in Newfoundland, originating along the access roads or ROW, during the summer	Reduction in air quality through the release of particulate matter and carbon dioxide into the atmosphere	– Adherence to terms and conditions of Operating Permits issued by Forest Services Branch – The SHERP will contain a fire prevention plan – The EPP will contain forest fire prevention measures and a fire response plan – Firefighting equipment will be available at each worksite – In the event of forest fire, steps will be taken to extinguish the fire (if safe to do so), and the fire will be reported to the provincial Forest Services Branch

The following sections provide a description of the conditions or activities that could lead to each incident, the likely effects of the incident on the Atmospheric Environment, and a description of prevention and mitigation measures that will be implemented by Nalcor. Additional information on each incident is provided in Chapter 5.

Large forest fire in Labrador, originating along the access roads or ROW, during the summer, or forest fire near a populated community in Newfoundland, originating along the access roads or ROW, during the summer.

Description of Incident

The operation of combustion engines (e.g., vehicles, heavy equipment, chainsaws) and blasting activity and have the potential to ignite forest fires. Combustion engines are expected to be present during most Project Construction, and Operations and Maintenance activities, and blasting may occur during foundation construction. Several Project activities will occur in forested areas where the ignition source could lead to a forest fire.

Given the provincial Forest Services Branch's policy not to fight fires that do not threaten communities or harvestable resources, a forest fire in Labrador could affect large tracts of land. A large forest fire in Labrador is considered to cover an area of approximately 470 ha (the average extent of forest fires in Labrador) or more. A similar fire in Newfoundland would be more actively fought but has a greater likelihood of approaching a populated community.

Likely Effects of Incident on the Atmospheric Environment

Forest fires can affect Air Quality through the release of particulate matter (e.g., ash, soot) into the atmosphere. Carbon dioxide and water vapour are also released into the atmosphere through the combustion of vegetation. Ambient air contaminant concentrations would increase, likely to levels above the objectives, guidelines and standards. Emissions from forest fires can travel long distances, thus likely affecting both air quality and visibility far from the fire location.

Summary of Prevention and Response Measures

The SHERP will include a plan for fire prevention and a fire response plan. The EPP will also contain fire prevention measures and the fire response plan. All Project personnel will be made aware of the SHERP and designated staff will receive SHERP training. The forest fire prevention plan will be followed by Nalcor and its contractors. Forest fire prevention measures addressed in the SHERP and EPP will include the storage and disposal of flammable material, and the prohibition of burning brush or debris.

Detailed information on firefighting equipment and procedures will be provided in the SHERP, the EPP and other environmental documents, such as terms and conditions of permits and authorizations. Firefighting equipment, as described in Chapter 5, that is suitable to the labour force and working conditions will be available at each worksite and will be in proper working condition, as required by the Operating Permit obtained from the Forest Services Branch to undertake logging or industrial operations during the forest fire season. In the event of a forest fire, immediate steps will be taken to contain or extinguish the fire to the extent practical and safe, and fires will be reported immediately to the nearest regional office of the Forest Services Branch, the branch of government responsible to coordinate the province's fire suppression program.

Summary of Assessment of Moderate to High Risk Accidents and Malfunctions

The likely effects of a large forest fire in Labrador or a forest fire near a community in Newfoundland on the Atmospheric Environment during Project Construction or Operations and Maintenance are primarily reduced Air Quality through the release of particulate matter and carbon dioxide into the atmosphere, and reduced visibility extending beyond the physical extent of the fire. Nalcor will implement fire prevention measures and adhere to conditions of Operating Permits. Firefighting equipment and trained personnel will be onsite and, if necessary, the fire response plan outlined in the SHERP (Section 5.10.1) and the EPP will be implemented. Consequently, forest fires will be prevented to the extent possible, and a forest fire that does occur will be dealt with quickly to reduce the spread of fire and reduced air quality. Prevention and response measures are in place and moderate to high risk forest fire incidents are unlikely to occur; therefore, the effects are not likely to be significant.

11.3.3 Residual Project Effects and Significance

The residual effects on the Atmospheric Environment resulting from the Project are of the same type and magnitude that are currently occurring throughout the province. A significant effect on the Atmospheric Environment VEC would be an effect that resulted from a significant effect on climate, air quality or sound within the RSA.

Environmental effects of the Project on the Atmospheric Environment are limited to GHGs, air contaminant emissions and noise primarily resulting from the operation of equipment and isolated blasting. The GHG emissions are estimated to be low. The air contaminant emissions and noise effects are likely to dissipate quickly and extend only a limited distance (i.e., less than 1 km) from the work area. Within the LSA, Air Quality and Sound will likely be slightly affected at a given location due to contaminant and noise emissions while Operations and Maintenance activities are occurring and due to coronal discharge. Environmental effects to air quality and sound are not likely to extend beyond the LSA.

The changes to the Atmospheric Environment resulting from the Project are likely to be negligible and are unlikely to substantively influence ambient conditions within the RSA, based on the prediction that there will be no significant effects on the Climate (GHG emissions) KI, Air Quality KI or Sound KI. Therefore, the Project is not likely to result in significant adverse effects on the Atmospheric Environment.

Table 11.3.3-1 provides a summary of the significance of effects on the Atmospheric Environment VEC.

Table 11.3.3-1 Summary: Significance of Effects on Atmospheric Environment

VEC	Likely Significant Effect	Comment
Atmospheric Environment	No	The likely effects on Climate, Air Quality and Sound during the Construction, and Operations and Maintenance of the Project consider proven, effective mitigation are unlikely to substantively influence ambient conditions in the RSA, and therefore are not significant

11.3.4 Cumulative Environmental Effects

The cumulative effects assessment considered the overall effect on the Atmospheric Environment VEC as a result of the Project's likely residual environmental effects that overlap both temporally and geographically with those of other projects and activities that have been or will be carried out. The existing environment considers all projects and activities that have been undertaken in the past, or are ongoing. The future projects and activities considered for the cumulative effects assessment included those with likely overlapping environmental effects within the RSA. This included effects (e.g., noise and emissions to the atmosphere) resulting from the Lower Churchill Hydroelectric Generation Project, Trans-Labrador Highway Phase 3 operations, 5 Wing Goose Bay supersonic flight training, commercial forestry activity, and general economic and infrastructure development.

Overall, the contributions of air contaminants and sound from the potential future projects will not add to the emissions from the Project such that ambient conditions would change noticeably, because each of the potential future projects will be located outside the RSA. Emissions of air contaminants from the Project will disperse quickly within the LSA, and when combined with emissions from potential future projects, are unlikely to substantively influence ambient air quality and thus are unlikely to overlap.

The Project-related contribution to change in global concentrations of GHGs is not substantive and the cumulative effects on Climate (GHG emissions) are not significant.

Cumulative effects on the Atmospheric Environment associated with the Project are expected to be limited due to the remote or rural nature of the majority of the Project components, and are predicted to be not significant.

11.3.5 Environmental Monitoring and Follow-up

A follow-up program to measure ambient air contaminant concentrations for the purpose of verifying the environmental effects predictions or the effectiveness of mitigation measures is not warranted.

Nalcor will employ a complaint driven process to address the generation of excessive airborne dust and / or noise during any phase of the Project. Nalcor will confirm the validity of the complaint and implement corrective actions as warranted and appropriate. In the event of complaints, ambient measurements may be conducted, if required, to identify the source and / or extent of the issue and identify appropriate mitigation measures.

11.4 References

Advanced Engineering Acoustics. 2010. Construction Noise Threshold Criteria and Control Plan. Prepared for the County of Ventura (California). Simi Valley, CA.

American Augers. n.d. DD-880 Horizontal Directional Drill, Product Specifications.

Argonne National Laboratory. 2007. The Design, Construction, and Operation of Long-Distance High-Voltage Electricity Transmission Technologies. Environmental Science Division, ANL/EVS/TM/08-4. Available at: http://solareis.anl.gov/documents/docs/APT_61117_EVS_TM_08_4.pdf. Accessed: March 2011.

BCMOE (British Columbia Ministry of Environment). 2009. Air Quality Objectives and Standards for British Columbia and Canada. British Columbia Ministry of Environment, Victoria, BC. Available at: http://www.bcairquality.ca/reports/pdfs/aqotable.pdf. Accessed: September 2011.

Burns & McDonnell Engineering Company, Inc. 2007. Environmental Assessment KAMO Electric Cooperative, Inc. Blackberry to Chouteau 345-kV Transmission Line Project. Prepared for the United States Department of Agriculture (Rural Utilities Services) by Burns & McDonnell Engineering Company, Inc. December 2007.

Canadian Centre for Occupational Health and Safety. 2011. http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/chlorine/health_chlorine.html. Accessed: October 2011.

Canadian Standards Association. 2005. CAN/CSA-ISO 1996-1:05 (ISO 1996-2:2003). Acoustics – Description, measurement and assessment of environmental noise. Part 1: Basic quantities, and assessment procedures. Canadian Standards Association, Canada.

CCME (Canadian Council of Ministers of the Environment). 2000. Canada-Wide Standards for Particulate Matter (PM) and Ozone. Available at: http://www.ccme.ca/assets/pdf/pmozone_standard_e.pdf. Accessed: June 2010.

CEA Agency (Canadian Environmental Assessment Agency). 2003. Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners. The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, November 2003. Available at: http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=A41F45C5-1. Accessed: June 2010.

Cheminfo Services Inc. 2005. Best Practices for the Reduction of Air Emissions From Construction and Demolition Activities. Prepared for Environment Canada, Transboundary Issues Branch. Markham, ON.

Climate Analysis Indicator Tools. 2010. Version 7.0. World Resources Institute, Washington, DC. Available at: http://cait.wri.org/login-main.php?log=5. Accessed: June 2010.

Eaton, S. 2000. Construction Noise. Workers' Compensation Board of BC, Engineering Section. ARCS Reference No.: 0135-20. Available at: http://www2.worksafebc.com/pdfs/hearing/ConstructionNoise.pdf. Accessed: March 2011.

Environment Canada. 2010a. News Release: Government of Canada to Regulate Emissions from Electricity Sector. Available at: http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=E5B59675-BE60-4759-8FC3-D3513EAA841C. Accessed: June 2010.

Environment Canada. 2010b. News Release: Canada and the United States Announce Common Standards for Regulating GHG Emissions from New Vehicles. Available at: http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=B1DDFE4D-5147-46F9-BA97-BA1BDDC3B7A6. Accessed: June 2010.

Environment Canada. 2010c. Search Facility Data – Results, Newfoundland and Labrador. Available at: http://www.ec.gc.ca/pdb/ghg/onlinedata/results_e.cfm?year=2008&gasorcas=gas&gas=all&cas=all&fac_name=&npri_id=&rep_comp=&location=province&prov=NL&city=22+km+NE+of+Fort+McMurray&postal=&naics=all&submit=Submit. Accessed June 2010.

Environment Canada. 2010d. Key Data Tables. Available at: http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=DF08C7BA-1. Accessed: June 2010.

ERCB (Alberta Energy Resources Conservation Board). 2007. Directive 038 – Noise Control. Calgary, AB.

EEA (European Environment Agency). 2010a. Civil and Military Aviation. EMEP/EEA Emission Inventory Guidebook 2009, updated December 2010. 1.A.3.a, 1.A.5.b Aviation. Copenhagen, Denmark.

EEA. 2010b. Exhaust emissions from road transport. EMEP/EEA Emission Inventory Guidebook 2009, updated June 2010. 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b. iii, 1.3.b.iv. Passenger cars, light-duty trucks, heavy-duty vehicles including buses and motor cycles. Copenhagen, Denmark.

ExxonMobil. 2008. World Jet Fuel Specifications with Avgas Supplement, 2008 Edition.

Fans, S.M., M.L. Goulden, J.W. Munger, B.C. Daube, P.S. Bakwin, S.C. Wofsy, J.S. Amthor, D.R. Fitzjarrald, K.E. Moore and T.R. Moore. 1995. Environmental controls on the photosynthesis and respiration of a boreal lichen woodland: a growing season of whole-ecosystem exchange measurements by eddy correlation. Oecologia (102): 443-452.

Farmers Weekly Interactive. 2008. Six ATVs Put to the Test. Available at: http://www.fwi.co.uk/Articles/2008/08/29/111777/Six-ATVs-put-to-the-test.htm. Accessed: March 2011.

FHWA (Federal Highway Administration). 2006. US Department of Transportation FHWA Roadway Construction Noise Model User's Guide. Final Report, January 2006. Report no. FHWA-HEP-05-054. Prepared by the US DOT, Research and Innovative Technology Administration.

Georgia Transmission Corporation. 2008a. Environmental Assessment Thomson-Warthen 500 kV Transmission Line. Prepared for the United States Department of Agriculture (Rural Utilities Services) by the Georgia Transmission Corporation, May 2008.

Georgia Transmission Corporation. 2008b. Environmental Assessment Cliftondale 230/25 kV Substation, Cavender Drive-Cliftondale 230kV Transmission Line, and Cavender Drive 230 kV Switching Station. Prepared for the United States Department of Agriculture (Rural Utilities Services) by the Georgia Transmission Corporation, October 2008.

Gilchrist, A., E.N. Allouche and D. Cowan. 2003. Prediction and mitigation of construction noise in an urban environment. Canadian Journal of Civil Engineering, 30: 659-672.

GNL (Government of Newfoundland and Labrador). 2004. Newfoundland and Labrador Regulation 39/04, Air Pollution Control Regulations. Available at: http://www.assembly.nl.ca/Legislation/sr/Regulations/rc040039.htm. Accessed: July 2010.

Guggemos, A. and A. Horvath. 2006. Decision-Support Tool for Assessing the Environmental Effects of Constructing Commercial Buildings. Journal of Architectural Engineering, December 2006, p. 187-195.

Health Canada. 2006. Regulations Related to Health and Air Quality. Available at: http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/reg-eng.php#a3. Accessed: June 2010.

Health Canada. 2009. Draft Health Canada Guidance on Noise Assessment for *CEAA* Projects.

ICF International. 2010. Greenhouse Gas Mitigation Measures for Transportation Construction, Maintenance, and Operations Activities. Prepared for American Association of State Highway and Transportation Officials, Standing Committee on the Environment. San Francisco, CA.

IPCC (International Panel on Climate Change). 2006a. Volume 2, Chapter 3, Mobile Combustion. IPCC Guidelines for National Greenhouse Gas Inventories.

IPCC. 2006b. Volume 2, Chapter 2, Stationary Combustion. IPCC Guidelines for National Greenhouse Gas Inventories.

IPCC. 2007. Summary for policy makers. In B. Metz, O.R. Davidson, P.R. Bosch, R. Dave and L.A. Meyer (ed.). Climate Change 2007: Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the International Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY.

ISO (International Organization for Standardization). 2003. Acoustics – Description, Measurement and Assessment of Environmental Noise: Part 1: Basic quantities and assessment procedures. ISO 1996-1:2003.

Jacques Whitford (Jacques Whitford Consulting Limited). 2006. Environmental and Socio-economic Assessment, Brunswick Pipeline Project. Prepared for Brunswick Pipeline. Fredericton, NB.

Jacques Whitford. 2009. Environmental Assessment Report, Route 1, Route 127 Area to St. George/Letang River. Prepared for New Brunswick Department of Transportation. Fredericton, NB.

Jahren, C.T. 2000. Transportation Construction Equipment. A2F06: Committee on Construction Equipment, Transportation Research Board. Available at: http://onlinepubs.trb.org/onlinepubs/millennium/00122.pdf. Accessed: March 2011.

Lee, Y-S., m. Skibniewski and W-S. Jang. 2009. Monitoring and Management of Greenhouse Gas Emissions from Construction Equipment Using Wireless Sensors. 26th Symposium on Automation and Robotics in Construction (ISARC 2009) p. 227-234.

Malhi, Y., D.D. Baldocchi and P.G. Jarvis. 1999. The Carbon Balance of Tropical, Temperate and Boreal Forests. Plant, Cell and Environment 22: 715-740.

NLDEC (Newfoundland and Labrador Department of Environment and Conservation). 2005. Climate Change Action Plan 2005. Government of Newfoundland and Labrador. Available at: http://www.env.gov.nl.ca/env/climate_change/govt_action/climatechangeplanfinal.pdf. Accessed: June 2010.

NRCan (Natural Resources Canada). 2011. Fuel Consumption Ratings – Results. Available at: http://oee.nrcan.gc.ca/transportation/tools/fuelratings/ratings-results.cfm. Accessed: March 2011.

New York State. 1989. Fugitive Dust Suppression and Particulate Monitoring Program (TAGM – 4031). Department of Environmental Conservation. Available at: http://www.dec.ny.gov/docs/regions_pdf/igwpappi.pdf. Accessed: March 2011.

Public Service Commission of Wisconsin. n.d. Environmental Impacts of Transmission Lines. Available at: http://psc.wi.gov/thelibrary/publications/electric/electric10.pdf. Accessed: March 2011.

Sonoma Technology Inc. 2010. Construction Activity, Emissions, and Air Quality Impacts: Real-World Observations from an Arizona Road-Widening Case Study. Prepared for Arizona Department of Transportation. Petaluma, CA.

Stantec (Stantec Consulting Ltd.). 2010a. Environmental Assessment, Route 11 Upgrading Shediac to Richibuc River. Prepared for New Brunswick Department of Transportation. Fredericton, NB.

Stantec. 2010b. Unpublished notes from field observations during Environmental Assessments for: LNG Terminal, Ridley Island, BC; Conoco Philips, Fort McMurray, AB; Lameque Wind Farm, Lameque, NB; Digby Wind Farm, Digby, NS; Voisey's Bay Mine, Voisey's Bay, NL (1994-2010). Halifax, NS.

TCR (The Climate Registry). 2008. General Reporting Protocol. Version 1.1.

TCR. 2011. 2011 Climate Registry Default Emissions Factors. Available at: http://www.theclimateregistry.org/downloads/2009/05/2011-Emission-Factors.pdf. Accessed: March 2011.

Universal Helicopters Newfoundland Ltd. 2003. Bell Helicopter Textron 407. Available at: http://www.uhnl.nf.ca/fleet.htm. Accessed: March 2011.

US EPA (United States Environmental Protection Agency). 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", EPA 550/9-74-004, March 1974, U.S. Environmental Protection Agency, Washington, D.C. 20460.

US EPA. 1980. AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Explosives Detonation. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. Available at: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s03.pdf. Accessed: March 2011.

US EPA. 1985. AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Appendix A. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. Available at: http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf. Accessed: March 2011.

US EPA. 1996a. AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 3.3 Gasoline and Diesel Industrial Engines. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. Available at: http://www.epa.gov/ttn/chief/ap42/ch03/final/c03s03.pdf. Accessed: June 2010.

US EPA. 1996b. AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 3.4 Large Stationary Diesel and All Stationary Duel-fuel Engines. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. Available at: http://www.epa.gov/ttn/chief/ap42/ch03/final/c03s04.pdf. Accessed: March 2011.

US EPA. 2005. Exhaust Emission Factors for Nonroad Engine Modeling – Spark-Ignition. NR-010f, EPA-420-R-10-019. Assessment and Standard Division, Office of Transportation and Air Quality.

WHO (World Health Organization). 1999. Guidelines for Community Noise. In B. Berglund, T. Lindvall and D.H. Schwela (ed.). World Health Organization, Geneva, April, 1999. Available at: http://whqlibdoc.who.int/hq/1999/a68672.pdf. Accessed: May 2010.

Wofsy, S. 2004. The Harvard Forest and Understanding the Global Carbon Budget. Chapter 19. In D.R. Foster and J.D. Aber (ed.). Forests in time; The Environmental Consequences of 1000 years of Change in New England. New Haven: Yale University Press.

NALCOR ENERGY

LABRADOR-ISLAND TRANSMISSION LINK

ENVIRONMENTAL IMPACT STATEMENT

Chapter 12

Terrestrial Environment: Environmental Effects Assessment

April 2012

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

Acronym	Description
%	percent
ACCDC	Atlantic Canada Conservation Data Centre
ANPC	Alberta Native Plant Council
APLIC	Avian Power Line Interaction Committee
APP	Avian Protection Plan
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWCS	Canadian Wetland Classification System
CWF	Canadian Wildlife Federation
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
EA	Environmental Assessment
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
EPP	Environmental Protection Plan
FILT	Forest Invasives Leadership Team
FMD	Forest Management District
GIS	Geographic Information System
GMV	Gross Merchantable Volume
GNL	Government of Newfoundland and Labrador
GNP	Great Northern Peninsula
GPS	Global Positioning System
GRH	George River Herd
HDD	Horizontal Directional Drill
HVdc	High-Voltage, Direct Current
IATNL	International Appalachian Trail Association of Newfoundland and Labrador
IFWD	Inland Fish and Wildlife Division
KI	Key Indicator
km	kilometre
km^2	square kilometre
LBHSP	Limestone Barrens Habitat Stewardship Project
LLTA	Low-Level Training Area

Acronym	**Description**
LRM	Long Range Mountains
LSA	Local Study Area
LWCRT	Labrador Woodland Caribou Recovery Team
m	metre
MCP	minimum convex polygons
MMH	Mealy Mountains Herd
MP	Measurable Parameter
MUNBG	Memorial University of Newfoundland Botanical Gardens
n.d.	no date
NLDE	Newfoundland and Labrador Department of Education
NLDEC	Newfoundland and Labrador Department of Environment and Conservation
NLDFRA	Newfoundland and Labrador Department of Forest Resources and Agrifoods
NLDNR	Newfoundland and Labrador Department of Natural Resources
NLEPA	Newfoundland and Labrador *Environmental Protection Act*
NLESA	*Newfoundland and Labrador Endangered Species Act*
NLOA	Newfoundland and Labrador Outfitters Association
NLRWG	Newfoundland and Labrador Riparian Working Group
NRCan	Natural Resources Canada
NSPLC	Nova Scotia Public Lands Coalition
OHV	off-highway vehicle
PPWSA	Protected Public Water Supply Area
Project	Nalcor Energy Labrador Island Transmission Link Project
ROW	right-of-way
RSA	Regional Study Area
RWMH	Red Wine Mountain Herd
SARA	*Species at Risk Act*
SHERP	Safety, Health and Environment Emergency Response Plan
TCH	Trans-Canada Highway
TLH	Trans-Labrador Highway
TLH3	Trans-Labrador Highway Phase 3
USFWS	United States Fish and Wildlife Service
VEC	Valued Environmental Component

12 TERRESTRIAL ENVIRONMENT

This Chapter of the Environmental Impact Statement (EIS) presents the environmental assessment for the Terrestrial Environment, which includes Vegetation, Avifauna, Caribou and Furbearers.

To assess the effects of the Labrador-Island Transmission Link (the Project) on the Terrestrial Environment, a number of Valued Environmental Components (VECs) were identified and have been assessed in the following sections.

12.1 Valued Environmental Component Selection

The environmental assessment is focused on Valued Environmental Components. VECs are aspects of the biophysical and socioeconomic environments which are of particular ecological and / or social importance, and which have the potential to be affected (adversely or positively) by the proposed Project. VECs reflect identified scientific and community concerns regarding the Project and its potential effects, and are typically identified early in an environmental assessment (EA) as a result of questions and issues raised through consultation with governments, Aboriginal and stakeholder groups, and the general public.

Initial direction and input into VEC selection for this EIS were obtained through the EIS Guidelines and Scoping Document (Government of Newfoundland and Labrador (GNL) and the Government of Canada 2011) that were issued to Nalcor Energy (Nalcor) following Aboriginal and public review. Following additional analysis by the EIS study team and Nalcor’s own consultation activities, that initial list of VECs was expanded and refined to include and reflect the key environmental components and issues that require detailed consideration in the EIS.

The ecosystem components of the Terrestrial Environment that require protection are the major constituents of the terrestrial habitat that are required to maintain environmental integrity, and the species that utilize the terrestrial habitat. The VECs that have been selected as the focus for the EA for the Terrestrial Environment, as well as the rationale for their selection, are described below.

Vegetation was selected as a VEC because it plays a fundamental role in the maintenance of healthy, functioning ecosystems (e.g., it contributes to biodiversity, maintenance of hydrological function, provision of wildlife habitat, and carbon sequestration) and social systems (e.g., traditional and commercial harvesting). In some cases, there are also regulatory requirements and jurisdictional or planning regimes that apply to the management of various species or habitats, particularly those considered at risk and listed by the *Species at Risk Act* (*SARA*) and the *Newfoundland and Labrador Endangered Species Act* (*NLESA)*.

Avifauna was selected as a VEC because of its social and economic importance (e.g., recreational viewing and hunting of waterfowl and upland game birds), and cultural importance (e.g., raptors and certain passerines). The status of bird populations is generally indicative of ecosystem health, since birds feed on vegetation and lower components of the food chain, and several species of conservation concern are supported by habitat in the Project area.

Caribou have been identified as a VEC because of their occurrence throughout the province, their role in the ecosystem, their economic and cultural importance, and because several herds in Labrador are of special conservation concern and protected under both provincial and federal legislation.

Furbearers have been selected as a VEC as they have been, and continue to be, traditionally harvested in Newfoundland and Labrador. Trapping is a source of income and recreation for many residents, and in Labrador, also represents an important Aboriginal cultural tradition.

The likely effects of the Project on these VECs are assessed in the following sections of this chapter.

Species of Special Conservation Concern (SSCC) is an integral component of this effects analysis. Table 12.1-1 lists the Terrestrial Environment SSCC addressed in this chapter and outlines the manner in which each species is integrally considered in the EA. This list includes consideration of all terrestrial species likely to occur in the study areas that are protected under the federal *Species at Risk Act* (SARA) (SARA 2011, internet site) or Newfoundland and Labrador *Endangered Species Act* (NL*ESA*) (GNL 2011, internet site), as well as those species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2011, internet site) or assessed by the Species Status Advisory Committee (SSAC) (NLDEC 2011a, internet site), for the Terrestrial Environment.

Table 12.1-1 Integral Consideration of Species of Special Conservation Concern in the Environmental Assessment

Species of Special Conservation Concern[a]	How Species is Addressed in the EIS
Long's braya	Assessed within the Listed Plant KI of the Vegetation VEC
Fernald's braya	Assessed within the Listed Plant KI of the Vegetation VEC
Fernald's milk-vetch	Assessed within the Listed Plant KI of the Vegetation VEC
boreal felt lichen	Assessed within the Listed Plant KI of the Vegetation VEC
woodland caribou	Assessed in the Caribou VEC
Newfoundland marten	Assessed in the Marten KI of the Furbearer VEC
Harlequin Duck	Assessed within the Waterfowl KI of the Avifauna VEC
Rusty Blackbird	Assessed within the Passerines KI of the Avifauna VEC
Red Crossbill	Assessed within the Passerines KI of the Avifauna VEC
Grey-cheeked Thrush	Assessed within the Passerines KI of the Avifauna VEC
Olive-sided Flycatcher	Assessed within the Passerines KI of the Avifauna VEC
Short-eared Owl	Assessed within the Raptors KI of the Avifauna VEC
Common Nighthawk	Assessed within the Other Species of Conservation Status KI of the Avifauna VEC
Red Knot	Assessed within the Other Species of Conservation Status KI of the Avifauna VEC

[a] Only Species of Special Conservation Concern that are expected to be present within the Study Area (COSEWIC 2011, internet site; GNL 2011, internet site; NLDEC 2011a, internet site; SARA 2011, internet site) are included in this analysis. See Chapter 10 Existing Biophysical Environment (Sections 10.3.3 to 10.3.7 and Table 10.5.11-1) for information about species presence.

12.2 Vegetation

12.2.1 Introduction

Vegetation crossed by the Project in Labrador exists generally in a natural pattern (i.e., has not been subject to anthropogenic disturbances) (Section 10.3.3), except for the portion along the Trans-Labrador Highway Phase 3 (TLH3) and the portion near the Strait of Belle Isle.

Throughout much of Newfoundland, the corridor crosses or follows areas of previous disturbance, including forest harvesting, highways (e.g., provincial Highway 430, the Trans-Canada Highway (TCH), provincial Highway 360, various regional routes), and existing transmission line rights-of-way (ROWs) (e.g., Nalcor's transmission line infrastructure on the Avalon Peninsula). In these areas, successional stages are altered.

Vegetation within the Study Area is also affected by the alteration of natural disturbance regimes, which include forest fires, outbreaks of defoliating insects, disease, and occasionally wind throw events (i.e., blow down of trees due to wind). In Newfoundland and Labrador, the magnitude and frequency of natural disturbance, particularly those affecting forest communities, varies depending on topography, tree species composition, stand age and regional climate.

Watercourses, waterbodies, and riparian shoreline crossed by the Project are primarily in a natural state and subject only to natural disturbance regimes (e.g., fire, wind throw) and / or senescence. Complexes of bog and fen classed wetlands (bog / fen and peatland complex) are ubiquitous in the transmission corridor, representing more than 93 percent (%) of the total 220 square kilometres (km^2) of wetland area identified. These are also typically in an undisturbed condition.

With respect to listed and regionally uncommon plants, areas most likely to support these species and / or their habitats are often associated with calcareous Lichen Heathland and calcareous Coniferous Forest Habitat types. Such locations were identified on both sides of the Strait of Belle Isle, on the Northern Peninsula, and near Grand Falls-Windsor (Stantec 2010a).

The boreal forest of Newfoundland and Labrador is relatively small and consists primarily of black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*) intermixed with a small component of other conifers and deciduous trees. Black spruce is the most abundant tree in Labrador and the second most abundant on the Island. Balsam fir forms about one-third of the forests in Labrador and two-thirds of the forests on the Island. Some of these forests have commercial and economic value, particularly in Central and Eastern Newfoundland where height, species, age and productivity of these spruce and fir forests facilitate the harvesting of timber. They are also valued province-wide for their cultural importance (domestic cutting, hunting, fishing, recreation) and as habitat for an array of wildlife.

12.2.2 Environmental Assessment Study Areas

12.2.2.1 Spatial Boundaries

The spatial boundaries for the Vegetation VEC include a Local Study Area (LSA) and a Regional Study Area (RSA).

The LSA is the area where Project-related components and activities that may affect vegetation will occur. The LSA therefore includes the 2 km wide transmission corridor while also considering the general nature and location of other Project activities and elements (e.g., access, electrode lines, camps, storage areas) (Figure 12.2.2-1).

The RSA is a broader 15 km wide study area that surrounds the LSA (Figure 12.2.2-1), and is consistent with the area for which the ecological land classification (ELC) was prepared and habitat quality analyses were completed. The RSA was also defined with consideration of the potential spatial extent of other Project-related disturbances, such as noise and dust, which can extend up to 1 km beyond the LSA.

12.2.2.2 Temporal Boundaries

As described in the EA Methods section, the temporal boundaries for the effects assessment are the Construction phase (period between the start of Construction and Project commissioning – approximately four years) and the Operations and Maintenance phase (indeterminate period following Project commissioning).

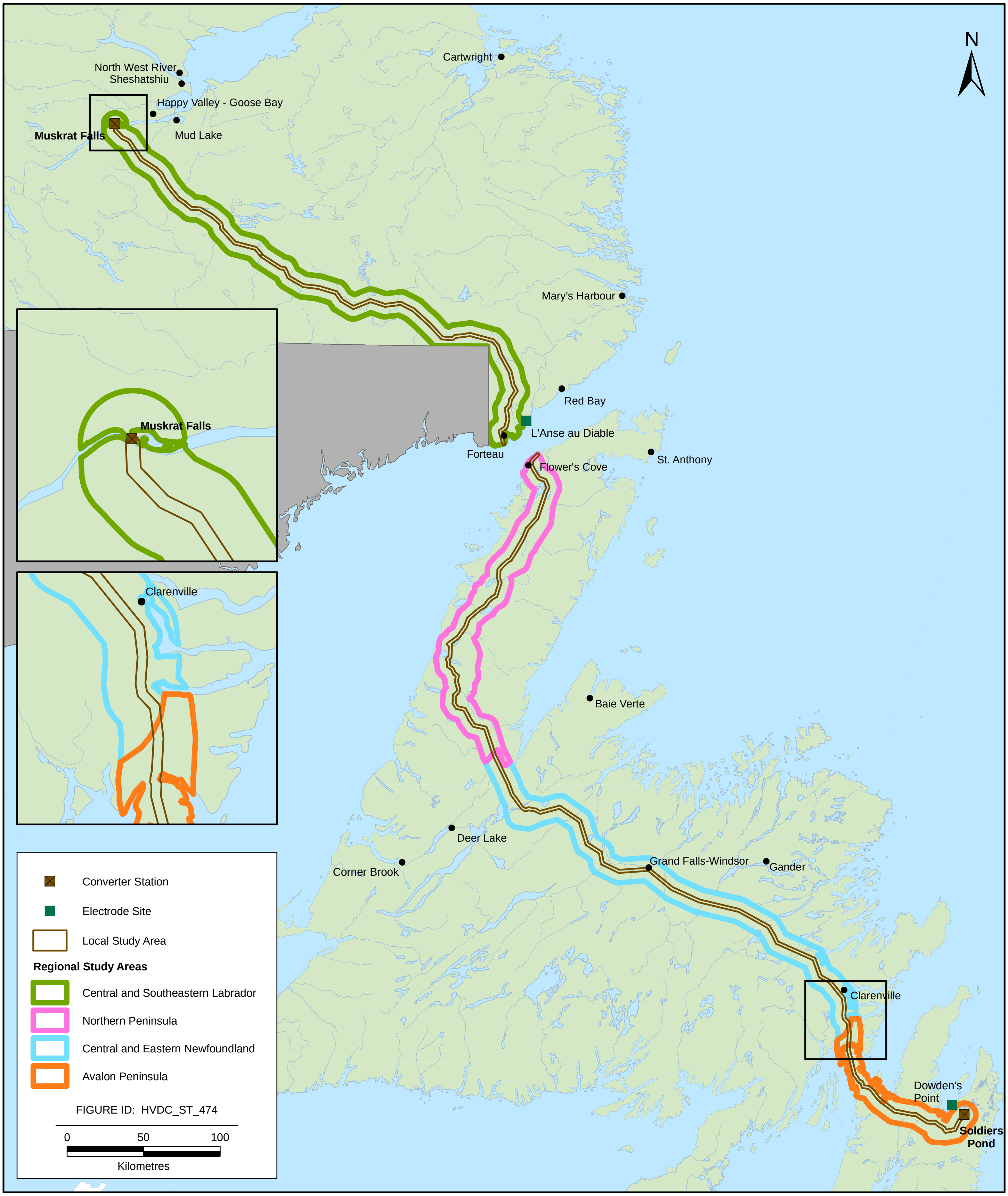


FIGURE 12.2.2-1

Local and Regional Study Area for Vegetation

12.2.3 Potential Environmental Issues, Indicators and Interactions

12.2.3.1 Potential Environmental Issues

As identified in the EIS Guidelines and Scoping Document (GNL and Government of Canada 2011), and through regulatory, Aboriginal, stakeholder, and study team consultation, identified issues and questions are summarized in Table 12.2.3-1. Project-related activities and potential interactions will be similar throughout the province, so it is not necessary to distinguish between geographic regions. Where regional differences do exist (i.e., location of known occurrences of listed plants and differences between regionally uncommon plant potential habitat in Labrador and in Newfoundland), these have been highlighted.

Table 12.2.3-1 Identified Issues and Questions: Vegetation

Issue / Question	Nature and Rationale	Specific Considerations
Degradation, alteration or loss of vegetation and vegetation communities, with resultant changes in habitat quantity and quality	– Clearing for the right-of-way (ROW) and other Project components must be performed to ensure proper clearances, safe operation and safe access for Construction, line inspection and Operations and Maintenance. – Removal of overstorey vegetation with subsequent shifts in abundance and diversity of understorey plant species may result in fragmentation of habitat or the transformation of natural landscapes with effects on ecosystem integrity, function, and biodiversity, which are directly linked to the provision and continuity of a complex of natural habitat units at the landscape level.	– Initial clearing will result in the removal of all impeding woody vegetation from the full 60 m width of the ROW. – Of particular concern is the alteration and / or loss of uncommon Habitat Types within the ROW within any of the four terrestrial geographic regions crossed by the Project. – Vegetation management (i.e., spraying and cutting), could lead to loss of organic matter, exposure of soil to erosion, and shifts in plant species composition.
Degradation, alteration or loss of wetland and / or riparian shoreline	– Wetlands and riparian areas are recognized and protected as valuable landscape features by the Federal Policy on Wetland Conservation (Government of Canada 1991) and the policy directive under the *Water Resources Act* (GNL 2002, internet site).	– Project activities may occur in or near wetlands and riparian areas during snow-free and ice-free conditions. – Difficulty of avoiding wetland habitat in Central and Southeastern Labrador and Central and Eastern Newfoundland where the density of occurrence is higher than other regions. – Potential for Project effects on uncommon and high functioning wetlands, such as riparian marsh.

Table 12.2.3-1 Identified Issues and Questions: Vegetation (continued)

Issue / Question	Nature and Rationale	Specific Considerations
Alteration or loss of individual listed and / or regionally uncommon plants	– Listed species are protected under *SARA* and the *NLESA*; the Project has the potential to affect listed species or their preferred habitat through habitat modification and / or direct removal / mortality of individual plants or populations. – Regionally uncommon plant species are vulnerable to the loss of individual plants, sensitive to changes in habitat and are of conservation concern to the Newfoundland and Labrador Department of Environment and Conservation (NLDEC) (Wildlife Division).	– The Project will result in disturbance of vegetation and could affect the abundance and distribution of *SARA*-listed species, in particular those associated with calcareous substrates as observed on the Northern Peninsula. – 138 species of regionally uncommon plant species and / or areas comprising suitable habitat for those species (Stantec 2010a) were identified within the LSA and could be affected. – Knowledge gaps exist in relation to the presence / absence of listed and / or regionally uncommon plants within the LSA, and the affect of construction activities on plant viability. In addition, gaps exist regarding the management of known occurrences of these plant species, particularly in Labrador.
Introduction and spread of non-native invasive species	– Non-native and invasive species could affect native plant species and / or plant populations through competitive exclusion, outcompeting natural vegetation for resources (e.g., available nutrients) and altering ecosystem function (e.g., nutrient cycling). – Linear corridors, including transmission line ROWs, access roads and trails are known to facilitate the introduction and / or prevalence of non-native and invasive species.	– Non-native and invasive species can be introduced and spread due to the transportation of equipment and vehicles (i.e., transferred soil and propagules) to, and within the LSA.
Degradation, alteration or loss of renewable natural resources (i.e., regenerating forests)[a]	– Construction of the Project (e.g., ROW) will permanently convert productive forest landbase to an early successional stage. – Merchantable timber from mature and over-mature forests will be cleared as a result of Project Construction.	– This is an important consideration where the corridor crosses mature forest types (i.e., merchantable timber) that are or will be scheduled for clearing over the life of the Project.
Alteration or loss of vegetation and associated habitat as a result of enhanced access for motorized vehicles	– Increased off-highway vehicle (OHV) use has the potential to affect listed and / or regionally uncommon plant species, sensitive habitats (including wetlands), promote introduction of non-native and invasive species and encourage resource exploitation (permitted and non-permitted domestic cutting of timber).	– Some areas of the Project will be chronically disturbed by Project-related vehicle traffic during Construction, and Operations and Maintenance. – Non-Project vehicle access will be related to proximity of the Project to populated areas (i.e., recreational activity) and could occur during both Project Construction and Operations and Maintenance.

[a] Concerns related to other cultural and community uses of vegetation, such as berry-picking and medicinal plant uses, are addressed in the Land and Resource Use VEC (Chapter 15 Land and Resource Use).

12.2.3.2 Key Indicators and Measurable Parameters

To focus and frame the effects analysis, Key Indicators (KIs) for the Vegetation VEC and associated Measurable Parameters (MPs) were selected (Table 12.2.3-2). The identification of KIs and MPs for Vegetation allows for the examination of ecologically important and / or sensitive plant species (or their habitats) that are relevant to or reflect the likely effects of the Project on Vegetation. Criteria used in the selection of KIs include: sensitivity to Project interactions; indicative of environmental effects on a larger component of the environment (e.g., landscape, community and species diversity); population status and vulnerability (e.g., listed or regionally uncommon plant species); and importance to Aboriginal, public and regulatory stakeholders.

12.2.3.3 Potential Project-Vegetation Interactions

Project activities have the potential to affect Vegetation and the identified KIs. All Project activities that will result in clearing of or disturbance to natural vegetation, or ground disturbance (e.g., grubbing, grading, excavation) have the potential to affect Vegetation. The specifics of all Project activities, physical works and Project interactions will be determined as part of ongoing Project engineering and design. The potential Project interactions with each of the KIs for the Vegetation VEC are identified in Table 12.2.3-3 with a brief summary of the rationale for their selection.

Table 12.2.3-2 Key Indicators and Associated Measurable Parameters: Vegetation

Key Indicator	Rationale for Key Indicator[a]	Measurable Parameter[b]	Rationale for Measurable Parameter
Vegetation Abundance and Diversity (refers to the diversity, abundance and distribution of Habitat Types that are present within a region)	– Represents the basis for evaluation of ecosystem health and biodiversity in the LSA – Uncommon vegetation types may support disproportionately unique and productive assemblages of plant species	– Extent (km^2) of a vegetation habitat type affected through physical disturbance relative to its availability in the RSA and LSA[c]	– Alteration to the habitat (e.g., creating openings in the forest, affecting drainage patterns) could affect vegetation species presence, ecosystem health and alter biodiversity
Wetlands (refers to land that has the water table at, near or above the ground surface, such as bogs, fens, marshes, swamps and other shallow open water areas)[d]	– Wetlands provide important ecological functions with respect to water quality, groundwater recharge, stormwater management, erosion control, wildlife habitat, biodiversity and carbon sequestration (Hanson et al. 2008) – Federal and provincial policies are in place to protect and conserve wetlands and limit adverse effects[e]	– Estimated proportion of wetland area (km^2) within each region of the LSA that has the potential to be affected by physical disturbance (by wetland class and form)[c]	– Alteration or loss of wetland area could affect vegetation species presence, ecosystem health and biodiversity – Provides a conservative estimate of the maximum amount of wetland that may potentially be affected and is used to guide mitigation measures
Riparian Shoreline (refers to habitat adjacent to watercourses and inland waterbodies)	– Vegetation plays a key role in bank stabilization, erosion prevention, provision and protection of fish habitat, regulation of water quality and quantity, sediment control, biodiversity, potential habitat for listed plants, corridors for the movement of wildlife and wildlife habitat	– Estimated length (km) of riparian shoreline affected through physical disturbance by class within the LSA (by region)[c]	– Alteration or loss of riparian shoreline could affect vegetation species presence, ecosystem health and biodiversity – Provides a conservative estimate of the maximum amount of riparian shoreline potentially affected and is used to guide mitigation measures
Listed Plant Species (refers to species provided regulatory protection[f] under *SARA* or the *NLESA*)	– All EAs conducted under federal legislation must identify any species at risk listed under *SARA*[g] that is likely to be affected by a project – Important habitat, as identified in a recovery strategy or action plan, is also protected	– Changes to the number of known individual listed plant species (i.e., Long's braya, Fernald's braya, Fernald's milk-vetch, boreal felt lichen), populations and / or their habitat within the LSA	– Alteration or loss of potential habitat could affect listed plant species presence, ecosystem health and biodiversity – Loss of federally or provincially listed plants contravenes federal (*SARA*) and / or provincial (*NLESA*) legislation

Table 12.2.3-2 Key Indicators and Associated Measurable Parameters: Vegetation (continued)

Key Indicator	Rationale for Key Indicator[(a)]	Measurable Parameter[(b)]	Rationale for Measurable Parameter
Regionally Uncommon Plant Species (refers to species identified by Atlantic Canada Conservation Data Centre (ACCDC) as SH (historical), S1 (extremely rare) and S2 (rare), but not currently listed under *SARA* or *NLESA)*	– A mandate of the NLDEC Wildlife Division includes the protection and conservation of native biodiversity; regionally uncommon plant species increase biodiversity – 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, rendering them sensitive to disturbance	– Changes to the number of regionally uncommon plants, as returned through queries of current ACCDC databases, within the LSA and RSA – Changes to the area of potential habitat (km^2) of listed and / or regionally uncommon plant species within the LSA and RSA	– Alteration or loss of potential habitat could affect regionally uncommon plant species presence, ecosystem health and biodiversity
Timber Resources (refers to natural resources collected from forests and considered as a source for wood)	– Forest communities are valued by people both intrinsically and for their ability to provide construction material, food, fuel, medicines, and recreation – Timber resources provide important economic (e.g., timber harvesting), social (e.g., food, domestic cutting, berry-picking) and ecological (e.g., habitat for wildlife, old growth forests) benefits	– Changes to the area (km^2) of productive, non-productive and non-forested land in the LSA[(c)] – Gross Merchantable Volume (GMV) (m^3) of timber removed from the LSA[(c)]	– Conversion of habitat within the ROW will represent a reduction in productive forested land – GMV (m^3) was used to reflect current timber volumes potentially affected

(a) Key Indicator: An aspect or characteristic of the VEC and / or its environment that, if changed because of the Project, may result in an effect on the VEC.
(b) Measurable Parameter: An environmental characteristic that is related to the status of a KI. Project effects to a MP can be detected and measured.
(c) Based on the use of a hypothetical centre line ROW of 60 m width, and a 20% contingency added to the affected area / length values, as a precautionary approach.
(d) As defined by the Newfoundland and Labrador *Water Resources Act (*GNL 2002, internet site).
(e) The Federal Policy on Wetland Conservation (Government of Canada 1991) states that its main objective is "to promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future". It aims to ensure "maintenance of the functions and values derived from wetlands throughout Canada", and "no net loss of wetland functions on all federal lands and waters in Canada". Provincially, a policy directive under the *Water Resources Act* (GNL 2002, internet site) currently protects wetlands. The objective of the provincial policy is "...to permit developments in wetlands which do not adversely affect the water quantity, water quality, hydrologic characteristics or functions, and terrestrial and aquatic habitats of the wetlands."
(f) Graceful felt lichen (*Erioderma mollissimum*) has also been identified within Newfoundland and Labrador, and qualifies as "endangered" by the Committee on the Status of Endangered Wildlife in Canada; however, it is not yet designated under *SARA*. Its occurrence is restricted to two disjunct locations, within the Avalon Forest Ecoregion (near the Hall's Gullies) and at Placentia on the Avalon Peninsula, consisting of 18 individuals from a total of 9 trees (Species Status Advisory Committee (SSAC) 2008).
(g) *SARA* establishes requirements that must be met before activities that may affect *SARA*-listed species are authorized. The *Act* underscores the importance of the mitigation sequence during project implementation. The preferred approach is to first adopt measures that would avoid the adverse effect, followed by measures that could minimize the effect. Ecological or habitat compensation is the least preferred option and should only be considered under certain circumstances.

Table 12.2.3-3 Potential Project Interactions: Vegetation

Project Phase / Activity	Key Indicator		
	Vegetation Abundance and Diversity	**Wetlands**	**Riparian Shoreline**
Construction			
Construction access trails and roads	– Direct loss of vegetation or vegetation communities due to clearing, grubbing and grading – Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction – Reduced health of vegetation or loss of vegetation due to increased erosion from access roads and / or dust generated by vehicles – Reduction in vegetation health and / or a reduction in vegetative cover and exposure of bare soils from vehicle traffic (heavy equipment and / or recreational OHV use) – Alteration of habitat due to changes in surface water hydrology (e.g., ponding, surface water run-off patterns) – Alteration of soil and water quality and resulting loss of plants due to accidental hydrocarbon spills	– Direct alteration or loss of wetland area due to vegetation clearing, infilling, changes in hydrology (e.g., ponding, surface water diversion), damage from heavy equipment and other vehicle traffic – Indirect alteration or loss of wetland area from increased erosion from access road traffic and / or dust generated by vehicles – Reduction in vegetation health and / or a reduction in vegetative cover from vehicle traffic (heavy equipment and / or recreational OHV use) – Displacement of natural vegetation due to non-native and invasive species introduction – Alteration of soil and water quality and resulting alteration or loss of wetland resulting from accidental hydrocarbon spills – Alteration of water quality (e.g., increased nutrient level from soil and vegetation disturbance)	– Direct alteration or loss of riparian habitat due to vegetation clearing, grading, changes in hydrology (e.g., ponding, surface water diversion), damage from heavy equipment and other vehicle traffic – Indirect alteration from increased erosion from access road traffic and / or dust generated by vehicles – Reduction in vegetation health and / or a reduction in vegetative cover and exposure of bare soils from vehicle traffic (heavy equipment and/ or recreational OHV use) – Displacement of natural vegetation due to non-native and invasive species introduction – Loss of plants due to exposure to hydrocarbons or other contaminants from spills or leaks – Alteration of water quality (e.g., increased nutrient level from soil and vegetation disturbance)
Movement and presence of personnel, equipment and materials	– Displacement of natural vegetation due to non-native and invasive species introduction – Alteration of soil and water quality and resulting loss of plants due to accidental hydrocarbon spills	– Displacement of natural vegetation due to non-native and invasive species introduction – Alteration of soil and water quality and resulting alteration or loss of wetland area resulting from accidental hydrocarbon spills	– Displacement of natural vegetation due to non-native and invasive species introduction – Loss of plants due to exposure to hydrocarbons or other contaminants from spills or leaks

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Vegetation Abundance and Diversity	**Wetlands**	**Riparian Shoreline**
Construction camps	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads
Marshalling yards and staging areas			
ROW clearing and preparation	– Direct loss of vegetation or vegetation communities due to clearing, grubbing and grading – Alteration or loss of vegetation or vegetation communities from altered natural disturbance regimes (e.g., stand senescence, blowdown, insect outbreaks) – Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction – Alteration of habitat due to changes in surface water hydrology (e.g., ponding, surface water run-off patterns) – Reduction in vegetation health and / or a reduction in vegetative cover and exposure of bare soils from vehicle traffic (heavy equipment and/ or recreational OHV use) – Alteration of soil and water quality and resulting loss of vegetation due to accidental hydrocarbon spills	– Direct alteration or loss of wetland area due to vegetation clearing, infilling, changes in hydrology (e.g., ponding, surface water diversion), damage from heavy equipment and other vehicle traffic – Displacement of natural vegetation due to non-native and invasive species introduction – Alteration of soil and water quality and resulting alteration or loss of wetland area resulting from accidental hydrocarbon spills – Alteration of water quality (e.g., increased nutrient level from soil and vegetation disturbance)	– Direct alteration or loss of riparian habitat due to grading, vegetation clearing, changes in hydrology (e.g., ponding, surface water diversion), damage from heavy equipment and other vehicle traffic – Displacement of natural vegetation due to non-native and invasive species introduction – Loss of plants due to exposure to hydrocarbons or other contaminants from spills or leaks – Alteration of water quality (e.g., increased nutrient level from soil and vegetation disturbance)
Quarrying and borrowing	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads
Transmission tower assembly and installation			

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Vegetation Abundance and Diversity	**Wetlands**	**Riparian Shoreline**
Conductor installation	– All interactions as listed under Movement and Presence of Personnel, Equipment and Materials	– All interactions as listed under Movement and Presence of Personnel, Equipment and Materials	– All interactions as listed under Movement and Presence of Personnel, Equipment and Materials
Converter station site preparation and construction Preparation and construction of submarine cable landing sites (on-land works)	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads
Construction and installation of submarine cables (Marine works)	–	–	–
Electrode site preparation and installation	– For on-land portions of this activity, refer to all interactions as listed under Construction Access Trails and Roads	– For on-land portions of this activity, refer to all interactions as listed under Construction Access Trails and Roads	– For on-land portions of this activity, refer to all interactions as listed under Construction Access Trails and Roads
Island system upgrades	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation
Employment / presence of workers Contracting / expenditures System commissioning	–	–	–

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Vegetation Abundance and Diversity	**Wetlands**	**Riparian Shoreline**
Operations and Maintenance			
Access trails and roads	– Maintained access could limit or preclude regeneration of areas required to be kept open for Operations and Maintenance – Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction and spread – Alteration and / or loss of vegetation from Project vehicles and / or recreational OHV use associated with increased access along trails and roads – Alteration of soil and water quality and resulting loss of vegetation due to accidental hydrocarbon spills	– Maintained access could limit or preclude regeneration of areas required to be kept open for Operations and Maintenance – Displacement of natural vegetation due to non-native and invasive species introduction and spread – Alteration of vegetation composition and site characteristics (e.g., shade, drainage pattern) resulting from operation of Project vehicles and / or OHV use associated with increased access along trails and roads – Alteration of soil and water quality and resulting alteration or loss of wetland area resulting from accidental hydrocarbon spills	– Maintained access could limit or preclude regeneration of areas required to be kept open for Operations and Maintenance – Displacement of natural vegetation due to non-native and invasive species introduction and spread – Alteration of vegetation composition and site characteristics (e.g., shade, drainage pattern) resulting from operation of Project –vehicles and / or OHV use associated with increased access along trails and roads – Alteration of soil and water quality and resulting alteration or loss of riparian habitat resulting from accidental hydrocarbon spills
Presence and operation of the transmission system	—	—	—
Routine line inspections and repairs	– Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction and spread – Alteration of soil and water quality and resulting loss of vegetation due to accidental hydrocarbon spills	– Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction and spread – Alteration of soil and water quality and resulting loss of alteration or loss of wetland area due to accidental hydrocarbon spills	– Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction and spread – Alteration of soil and water quality and resulting alteration or loss of riparian habitat resulting from accidental hydrocarbon spills

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Vegetation Abundance and Diversity	**Wetlands**	**Riparian Shoreline**
Vegetation management	– Alteration of natural vegetation composition (i.e., maintenance of an early successional stage development) and site characteristics (e.g., shade, drainage pattern) – Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction and spread – Alteration of soil and water quality and resulting loss of vegetation due to accidental hydrocarbon spills	– Alteration in composition or structure of terrestrial (upland) environments – Alteration of water quality and quantity due to vegetation management in adjacent upland areas – Alteration of water quality and subsequent alteration of wetland area from herbicide application	– Alteration in composition or structure of terrestrial (upland) environments – Alteration of water quality and quantity due to vegetation management in adjacent upland areas – Alteration of water quality and subsequent alteration of riparian habitat from herbicide application
Potential major system repairs	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation
Operation of the electrodes	—	—	—
Employment / presence of workers			
Contracting / expenditures			

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Listed Plants	**Regionally Uncommon Plant Species**	**Timber Resources**
Construction			
Construction access trails and roads	– Alteration or loss of individual listed plants, or habitat capable of supporting listed plant species, due to clearing, grubbing and grading – Alteration of preferred habitat due to changes in surface water hydrology (e.g., ponding, surface water run-off patterns) – Reduced health of individual plants or loss of plants due to increased erosion from access roads and / or dust or direct disturbance generated by vehicles – Displacement of listed plants due to non-native and invasive species introduction – Loss of plants or reduced health of individual listed species plants and /or their habitat due to exposure to hydrocarbons or other contaminants from spills or leaks	– Alteration or loss of individual regionally uncommon plants, or habitat capable of supporting those species due to clearing, grubbing and grading – Alteration of preferred habitat due to changes in surface water hydrology (e.g., ponding, surface water run-off patterns) – Reduced health of individual plants or loss of plants due to increased erosion from access roads and / or dust generated by vehicles – Reduction in vegetation health and / or a reduction in vegetative cover and exposure of bare soils from vehicle traffic (heavy equipment and/ or recreational OHV use) – Displacement of regionally uncommon plants due to non-native and invasive species introduction – Loss or reduced health of individual plants and / or their habitat due to exposure to hydrocarbons or other contaminants from spills or leaks	– Loss of merchantable timber and / or productive forested land due to clearing, grubbing and grading – Increased potential for the spread of forest insects and other diseases from clearing and other practices (e.g., stockpiling), contaminated material on equipment, or from increased susceptibility of damaged or stressed trees – Indirect alteration of mature and old growth forests from edge effects (i.e., the influence of recently clearing areas on adjacent forest) through changes in the spatial arrangement of forest stands or as a result of altered natural disturbance regimes (e.g., stand senescence, blowdown, insect outbreaks)

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Listed Plants	**Regionally Uncommon Plant Species**	**Timber Resources**
Movement and presence of personnel, equipment and materials	– Displacement of listed plants due to non-native and invasive species introduction – Loss of plants or reduced health of individual listed species plants and / or their habitat due to exposure to hydrocarbons or other contaminants from spills or leaks	– Displacement of listed plants due to non-native and invasive species introduction – Loss of plants or reduced health of individual listed species plants and / or their habitat due to exposure to hydrocarbons or other contaminants from spills or leaks	—[a]
Construction camps	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads	– All interactions as listed under Construction Access Trails and Roads
Marshalling yards and staging areas			
ROW clearing and preparation	– Alteration or loss of individual listed plants, or habitat capable of supporting listed plant species, due to clearing, grubbing and grading – Alteration of preferred habitat due to changes in surface water hydrology (e.g., ponding, surface water run-off patterns) – Displacement of listed plants due to non-native and invasive species introduction – Loss of plants or reduced health of individual listed plants and / or their habitat due to exposure to hydrocarbons or other contaminants from spills or leaks	– Alteration or loss of individual regionally uncommon plants, or habitat capable of supporting those species due to clearing, grubbing and grading – Alteration of preferred habitat due to changes in surface water hydrology (e.g., ponding, surface water run-off patterns) – Displacement of regionally uncommon plants due to non-native and invasive species introduction – Loss or reduced health of individual plants and / or their habitat due to exposure to hydrocarbons or other contaminants from spills or leaks	– Loss of merchantable timber and / or productive forested land due to clearing, grubbing and grading – Increased potential for spread of forest insects and other diseases from clearing and other practices (e.g., stockpiling), contaminated material on equipment, or from increased susceptibility of damaged or stressed trees – Indirect alteration of mature and old growth forests from edge effects (i.e., the influence of recently cleared areas on adjacent forest) through changes in the spatial arrangement of forest stands or as a result of altered natural disturbance regimes (e.g., stand senescence, blowdown, insect outbreaks)

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

<table>
<tr><th rowspan="2">Project Phase / Activity</th><th colspan="3">Key Indicator</th></tr>
<tr><th>Listed Plants</th><th>Regionally Uncommon Plant Species</th><th>Timber Resources</th></tr>
<tr><td>Quarrying and borrowing</td><td rowspan="2">– All interactions as listed under Construction Access Trails and Roads</td><td rowspan="2">– All interactions as listed under Construction Access Trails and Roads</td><td rowspan="2">– All interactions as listed under Construction Access Trails and Roads</td></tr>
<tr><td>Transmission tower assembly and installation</td></tr>
<tr><td>Conductor installation</td><td>– All interactions as listed under Movement and Presence of Personnel, Equipment and Materials</td><td>– All interactions as listed under Movement and Presence of Personnel, Equipment and Materials</td><td>– All interactions as listed under Movement and Presence of Personnel, Equipment and Materials</td></tr>
<tr><td>Converter station site preparation and construction</td><td rowspan="2">– All interactions as listed under Construction Access Trails and Roads</td><td rowspan="2">– All interactions as listed under Construction Access Trails and Roads</td><td>– All interactions as listed under Construction Access Trails and Roads</td></tr>
<tr><td>Preparation and construction of submarine cable landing sites (on-land works)</td><td rowspan="2">—</td></tr>
<tr><td>Construction and installation of submarine cables (Marine works)</td><td>—</td><td>—</td></tr>
<tr><td>Electrode site preparation and installation</td><td>– For on-land portions of this activity, refer to all interactions as listed under Construction Access Trails and Roads</td><td>– For on-land portions of this activity, refer to all interactions as listed under Construction Access Trails and Roads</td><td>– For on-land portions of this activity, refer to all interactions as listed under Construction Access Trails and Roads</td></tr>
<tr><td>Island system upgrades</td><td>– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation</td><td>– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation</td><td>– Increased potential for spread of forest insects and other diseases from clearing and other practices (e.g., stockpiling), contaminated material on equipment, or from increased susceptibility of damaged or stressed trees</td></tr>
</table>

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Listed Plants	Regionally Uncommon Plant Species	Timber Resources
Employment / presence of workers	—	—	—
Contracting / expenditures			
System commissioning			
Operations and Maintenance			
Access trails and roads	– Maintained access could limit or preclude regeneration of areas required to be kept open for Operations and Maintenance – Displacement of natural vegetation due to non-native and invasive species introduction and spread – Alteration of vegetation composition and site characteristics (e.g., shade, drainage pattern) resulting from operation of Project vehicles and / or OHV use associated with increased access along trails and roads – Alteration of soil and water quality and resulting loss of vegetation resulting from accidental hydrocarbon spills	– Maintained access could limit or preclude regeneration of areas required to be kept open for Operations and Maintenance – Displacement of natural vegetation due to non-native and invasive species introduction and spread – Alteration of vegetation composition and site characteristics (e.g., shade, drainage pattern) resulting from operation of Project vehicles and / or OHV use associated with increased access along trails and roads – Alteration of soil and water quality and resulting loss of vegetation resulting from accidental hydrocarbon spills	– Increased potential for spread of forest insects and other diseases from clearing and other practices (e.g., stockpiling), contaminated material on equipment, or from increased susceptibility of damaged or stressed trees – Potential for increased domestic clearing (i.e., wood cutting) in areas not presently designated for cutting due to increased OHV access
Presence and operation of the transmission system	—	—	—

Table 12.2.3-3 Potential Project Interactions: Vegetation (continued)

Project Phase / Activity	Key Indicator		
	Listed Plants	**Regionally Uncommon Plant Species**	**Timber Resources**
Routine line inspections and repairs	– Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction and spread – Alteration of soil and water quality and resulting alteration or loss of vegetation resulting from accidental hydrocarbon spills	– Displacement of natural vegetation or vegetation communities (fragmentation) or changes in landscape diversity (homogeneity) due to non-native and invasive species introduction and spread – Alteration of soil and water quality and resulting alteration or loss of vegetation resulting from accidental hydrocarbon spills	—
Vegetation management	– Alteration of natural vegetation composition (i.e., maintenance of an early successional stage development) and site characteristics (e.g., shade, drainage pattern, microclimates) – Effects on individual listed plants, or habitat capable of supporting those species may be positive or negative depending on the particular habitat affinities of the individual species	– Alteration of natural vegetation composition (i.e., maintenance of an early successional stage development) and site characteristics (e.g., shade, drainage pattern, microclimates) – Effects on individual listed plants, or habitat capable of supporting those species may be positive or negative depending on the particular habitat affinities of the individual species	– Alteration of natural vegetation composition (i.e., maintenance of an early successional stage development) and site characteristics (e.g., shade, drainage pattern) – Maintained access to, and along, the row would limit or preclude regeneration of vegetation
Potential major system repairs	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation	– All interactions as listed under Construction Access Trails and Roads, and right-of-way Clearing and Preparation	—
Operation of the electrodes	—	—	
Employment / presence of workers			
Contracting / expenditures			

(a) "—" indicates no likely or detectable interaction identified.

12.2.4 Approach to the Environmental Effects Analysis

12.2.4.1 Analytical Methods

Baseline conditions were established for each KI using data collected by the study team and others throughout the province (e.g., Atlantic Canada Conservation Data Centre (ACCDC), NLDEC, Newfoundland and Labrador Department of Natural Resources (NLDNR)), as presented in the *Labrador–Island Transmission Link Ecological Land Classification Component Study* (Stantec 2011a; Stantec 2010b); *Labrador–Island Transmission Link Wetland Inventory and Classification Component Study* (Stantec 2011a; Stantec 2010c); *Labrador–Island Transmission Link Regionally Uncommon Plant Potential Mapping Component Study* (Stantec 2011a; Stantec 2010a); *Labrador–Island Transmission Link Timber Resources Component Study* (Stantec 2011a, b); and the *Listed and Regionally Uncommon Plant Survey: Strait of Belle Isle Cable Landing Areas and Shore Electrode Sites Supplementary Report* (Stantec 2011c). This information is presented in Section 10.3.3 as the existing environment conditions for Vegetation within the Study Area.

To assess the environmental effects of the Project on the Vegetation VEC, an ELC (Stantec 2011a; Stantec 2010b) was developed and associated mapping was generated to provide a consistent, spatial context for the effects assessment. As described in Section 10.3.3, the ELC was based on a hierarchical framework and describes the ecological mosaic of the RSA from Muskrat Falls to Soldiers Pond. It provides a basis to quantify and understand the effects of the Project on Vegetation. The classification of vegetation into ecological units or Habitat Types was achieved using standard and well-validated methodology (Marshall and Schutt 1999). For a detailed description of the ELC methods and associated mapping, refer to the *Labrador-Island Transmission Link Ecological Land Classification Component Study* (Stantec 2010b) and the *Labrador-Island Transmission Link Vegetation Supplementary Report* (Stantec 2011a).

Project design including the ROW alignment has not been finalized. To inform the assessment, a hypothetical 60 m wide ROW was used, centred within the transmission corridor. The final ROW alignment could occur anywhere within the transmission corridor, ultimately depending on a number of factors including the avoidance of sensitive environmental features (e.g., wetlands and listed plants), and the locations of access trails and some Project components, which will be finalized during final Project engineering. The final ROW alignment or access trails may occasionally occur outside the transmission corridor, and the location of specific Project components may also be constructed outside of the corridor. As well, the approximately 32 km of access roads required will be constructed outside of the corridor. To account for these anticipated alignment deviations and uncertainty related to Project component locations (e.g., routing of access roads), a conservative 20% contingency has been added to distances or areas generated relative to the hypothetical ROW.

The values generated in the following assessment (for all KIs with the exception of Listed Plants) are based on the hypothetical centre line ROW and are for general analytical and illustrative purposes only, recognizing that Nalcor will be avoiding environmental sensitivities to the extent practical during final ROW routing.

For the purposes of this assessment, the effects analysis considers the nature and degree of Project-induced change from baseline conditions. Project-related changes are predicted based on typical effects resulting from similar transmission projects, and the experience of Nalcor in construction and operation of transmission infrastructure throughout the province. The assessment considers the nature and degree of Project-induced effects following implementation of standard mitigation practices by Nalcor. Management challenges are also discussed, where appropriate, including requirements to implement measures required by provincial and federal agencies, such as the avoidance of areas of listed or regionally uncommon plants.

Vegetation Abundance and Diversity

Project effects on Vegetation Abundance and Diversity were informed by superimposing the Project elements, particularly the hypothetical 60 m wide centre line ROW, over existing ecological conditions (i.e., mapped polygons or Habitat Types). A Geographic Information System (GIS) program (GIS ArcInfo) was used to query the mapped ELC data, to determine the area (km^2) of each polygon or Habitat Type crossed by the centreline ROW. For each Habitat Type, the amount of habitat within the hypothetical centre line ROW (plus the 20% contingency) has been expressed as a percentage of habitat available within the LSA as an estimate of the scale of potential habitat alteration / loss.

For this KI, alteration or loss of vegetation is defined as:

- Areas where surface disturbance will result in the alteration of vegetation (i.e., lands that will be directly disturbed during construction activities but will not be subject to grubbing or removal of litter layers, surface organic matter (humus) and mineral soil horizons) (e.g., the majority of the ROW, lay-down areas, temporary workspaces).
- Areas where surface disturbance will result in the loss of vegetation resulting from clearing, and removal of litter layers, surface organic matter (humus) and mineral soil horizons). This applies to access roads, converter stations, tower foundations, borrow sites, marshalling yards, and on-shore horizontal directional drill (HDD) sites at the Strait of Belle Isle.

Alteration of a Habitat Type through disturbance (i.e., clearing) changes the vegetation community, but, given enough time, the original Habitat Type and thus vegetation community will recover. For the purposes of this assessment, alteration / loss of defined Habitat Types (i.e., changes in the proportion, vigour and / or health of vegetation) could result for all Project components regardless of the type of associated surface disturbance. The post-construction Habitat Types and their areas were compared to baseline (pre-construction) conditions to determine the potentially affected area.

The loss of Habitat Type, particularly those identified as “uncommon”, as a result of the Project is of particular relevance to the Vegetation Abundance and Diversity KI. For the purposes of this this EA, uncommon Habitat Types are defined as those Habitat Types occupying less than 1% of the LSA, by region.

Wetlands

Baseline MP data for Wetlands were established during the Wetlands Inventory and Classification Study as part of the ELC process (Stantec 2010c). As described in Chapter 10, wetlands were delineated and mapped within the RSA. The wetlands within the LSA were then classified according to the Canadian Wetland Classification System (CWCS) (National Wetlands Working Group (NWWG) 1997). This approach focused efforts on collecting data from wetlands with the highest potential of Project interaction (i.e., within the LSA), while collecting data at the appropriate scale for regional comparisons (i.e., within the RSA). The resulting datasets were geo-referenced for each region, indicating the location and area of individual wetlands within the RSA, and the location, area and CWCS class and form of individual wetlands within the LSA.

For the purpose of this assessment, wetland alteration is defined as changes to the wetland class or form, or changes to the performance of wetland functions resulting from disturbance to vegetation, soils, or hydrology. Changes to the wetland class or form, or performance of wetland functions may occur during the Project activities, as outlined in Table 12.2.3-3. These areas may continue to function as a wetland, although the performance of functions and the hydrological, biogeochemical and ecological character may differ from baseline conditions.

Wetland loss is defined as conversion of wetland to non-wetland (e.g., upland, lake, pond or watercourse) due to infilling, excavation or alteration to the hydrology. The conversion of wetland to non-wetland may occur during the construction of permanent structures (e.g., access roads, tower foundations, converter stations). Conversion of wetland to non-wetland may also occur as an indirect result of construction activities that alter local hydrology (e.g., impedance of flow through an area of compaction or in-fill or enhanced drainage of a wetland area by surface grading adjacent to a wetland).

The likely Project effects on wetlands (by class and form) in the LSA within each region were informed by superimposing the hypothetical 60 m wide centre line ROW on the georeferenced inventory of wetlands in the

LSA in a GIS database. This query produced a subset of data including the area, CWCS class and form (NWWG 1997), and the total number of all wetlands intersected by the centre line ROW, by region. These values (plus the 20% contingency) were compared with the abundance and distribution of those wetland classes and forms in the LSA (by region).

The wetland areas intersecting the centre line ROW estimate the amount likely altered by Project Construction and Operations and Maintenance. The actual amount would be lower as the final ROW alignment will be selected to minimize wetland intersection for both environmental and engineering reasons. Additionally, within the final ROW alignment, temporary and permanent structures, vegetation clearing and management in wetland areas will be minimized.

Riparian Shoreline

The Project effects on Riparian Shoreline were estimated as the proportion of riparian shoreline potentially altered within the LSA by region. There is no source of riparian shoreline mapping in the RSA, and so for the purposes of this assessment, the lengths of shoreline along the 1:50,000 mapped waterbodies (e.g., lakes and ponds) and watercourses (e.g., rivers and brooks) have been used as a measure of riparian shoreline occurrence in the LSA (Natural Resources Canada (NRCan) 2010, internet site). In pristine and undeveloped regions of the LSA, this measure is representative of the riparian shoreline occurrence; however, in areas of development where the vegetation and character of riparian areas may have been altered, this may be an overestimate of the quantity of riparian shoreline. Riparian areas were classed according to the setback requirements for various waterbody types in designated Protected Public Water Supply Areas (PPWSA) (NLDEC 1999, internet site) and protected scheduled salmon rivers (Fisheries and Oceans Canada (DFO) 2009, internet site) (refer to Section 10.3.3 for additional information).

Alteration to riparian shoreline was defined as any surface disturbance (e.g., infilling, excavation, vegetation or soil disturbance) of riparian shorelines.

The EA was informed by determining the riparian shoreline intersected by the hypothetical 60 m wide centre line ROW that had the potential to be altered during the Project activities. The potential amount of riparian shoreline affected by the Project in each region of the LSA was estimated by superimposing the centre line ROW on the georeferenced inventory of riparian shorelines in the LSA in a GIS database. This spatial query produced a subset of data describing the length of riparian shoreline (by waterbody class) intersected by the centre line ROW in each region. Within each region the calculated riparian shoreline lengths (including a 20% contingency) were grouped by shoreline class (DFO 2009, internet site; NLDEC 1999, internet site). These lengths were divided by the lengths of corresponding shorelines crossed by the LSA. This provided a measure of the maximum proportion of riparian shoreline in the LSA that could potentially be affected by the Project.

Listed Plants

As described in Chapter 10, known occurrences of *SARA* and / or *NLESA*-listed plant species were delineated and mapped within the LSA, with each of those occurrences classified according to their particular ELC habitat affinity. This approach focused on the identification of listed plant species and their locations within the LSA. In July 2011, Nalcor conducted a plant survey of both cable landing sites, and the electrode sites for listed plants to identify known locations of listed plants. In addition, Nalcor also used known locations obtained from spatial data contained within the *SARA* Public Registry (Environment Canada 2011a, internet site), data compiled within existing provincial conservation data centres (i.e., ACCDC 2010, internet site; ACCDC 2008, internet site), information from local interest groups focused on the preservation of listed species (e.g., Limestone Barrens Habitat Stewardship Project (LBHSP) (LBHSP 2010, internet site)) and individuals or locations identified during Project component field studies. Available data were also presented at the appropriate scale for regional comparisons (i.e., in the RSA). Species currently being assessed by the provincial Species Status Advisory Committee (SSAC) (SSAC 2011, internet site) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2011, internet site) were also considered in this assessment.

The EA was informed by considering the potential for individuals or locations of listed plant populations crossed by the LSA to be affected during Project Construction (e.g., clearing) and Operations and Maintenance (e.g., vegetation management). Indirect effects to listed plants within and outside the ROW may result from adjacent or nearby vegetation, soil and / or drainage alteration.

The predicted Project effects on listed plants in each region crossed by the LSA were informed by superimposing the spatial distribution of known *SARA*-listed plant species occurrences on the geo-referenced inventory of listed plant locations within or adjacent to the LSA. A spatial query of the database then produced a subset of data including the individual locations of *SARA* and / or *NLESA*-listed plant species within the LSA, improved knowledge about their habitat affinities within the LSA, and the relative number of known listed plant species occurrences potentially intersected by the Project, by region. The hypothetical centre line ROW and 20% contingency were not used in the assessment of this KI, as Nalcor will avoid known occurrences of listed plants to the extent practical during final routing of the ROW or employ appropriate mitigation. Thus, a comparison with the centre line ROW and individual locations of listed plants are not applicable.

Regionally Uncommon Plant Species

Due to the spatial scale of the Project, it was important to design an approach to the evaluation of the Regionally Uncommon Plant Species KI that ensured sufficient detections for the analysis of frequency or probability of occurrence.

To assist final Project design and mitigation planning (i.e., avoidance to the extent practical) for regionally uncommon plant species, a habitat-based model (Stantec 2010a) was developed and employed. For this Project, habitat modelling was selected as an effective tool for identifying Regionally Uncommon Plant Species and their preferred habitat. Regional-scale habitat assessments are useful in facilitating Project design and to mitigate effects on regionally uncommon plant resources, or to improve the spatial allocation of resources to conduct pre-construction botanical surveys.

Habitat Type associations for a list of regionally uncommon plant species were identified, both for Labrador and the Island of Newfoundland. This list was compiled based on data from federal and provincial publications, including species identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and those listed under the *NLESA*, as well as the ACCDC database.

Habitat models were developed at an appropriate spatial scale using available GIS data (ACCDC 2010, internet site). To distinguish between habitat and non-habitat areas, and subsequently identify suitable Habitat Types and / or subunits with the potential to support populations of regionally uncommon plant species, species distribution data for plant species considered uncommon were consulted to determine the likelihood of occurrence in the RSA. The habitat preferences of the species that may occur in the area were then compared to the ELC data (*Labrador-Island Transmission Link Ecological Land Classification Component Study* (Stantec 2011a; Stantec 2010b)) to determine if suitable habitat was present. Additional inputs were derived from a GIS database composed of provincial and Project-related bedrock geology (adding attributes for calcareousness), soils, vegetation type and hydrography data that are known to have a direct relationship to the presence of the regionally uncommon plant species, particularly those plant species with affinities for calcium-rich substrates. Details of the modelling exercise and results are provided in Stantec 2011a and Stantec 2010b.

The model was used to produce thematic maps of the RSA and LSA depicting the locations of suitable Habitat Types and / or sub units and the likelihood (i.e., Low, Medium, High, and Very High) of encountering the identified species. This allowed the determination of the potential ratings for ELC Habitat Type for each mapped polygon, by geographic region. Maps were colour-coded to reflect habitat potential and indicate the percentage of identified Low, Moderate, High and Very High habitat available within the ELC Habitat Types that comprise the LSA and RSA. To obtain the elevated ratings of High and Very High, a combination of specific polygons known to have regionally uncommon plant species and Habitat Types and Sub-units were combined.

To provide greater definition of habitat, and to inform the EA on the potential of a particular Habitat Type and / or sub unit to support regionally uncommon plants, the GIS database and thematic habitat map products were queried to calculate the amount and distribution of appropriately identified habitat crossed by the LSA. This spatial query produced a subset of data describing the total area of regionally uncommon plant habitat, rated High and Very High, and crossed by the LSA and the hypothetical 60 m wide centre line ROW (plus 20% contingency). Nalcor will avoid regionally uncommon plants and their associated habitat to the extent practical. The values produced provide a conservative estimate of the amount of habitat for regionally uncommon plants in the LSA potentially affected by the Project.

Timber Resources

Baseline data for the Timber Resources KI were established in the *Labrador – Island Transmission Link Timber Resources Component Study* (Stantec 2011a, b). As described in Chapter 10, timber resources were delineated and GMV estimated in each region crossed by the LSA.

Within Newfoundland and Labrador, Project effects on Timber Resources were assessed as the proportion of productive forest landbase (i.e., productive forest areas within the overall land base in which timber harvesting activities have the potential to occur) containing merchantable volumes of available timber to be cleared during clearing activities of the Project. A detailed inventory of Timber Resources (Stantec 2011a, b) was used to evaluate and quantify the existing Timber Resource in the LSA, as well as the resources potentially affected by the clearing of the ROW, represented by the hypothetical 60 m wide centre line ROW (plus 20% contingency).

For Newfoundland, existing provincial forest inventory data (GNL 2005) obtained from the Forest Resources Branch of the NLDNR were used to estimate the merchantable volume of timber for all softwood and hardwood stand types occurring within the LSA and centre line ROW. The estimated merchantable volume for each identified “productive” and “non-productive” forest stand / unit was then expanded to provide volume estimates by combining average plot values (m^3/ha) within designated strata with forested areas (hectares) from the forest inventory data.

In Labrador, comprehensive inventory databases are limited for the majority of Forest Management Districts (FMDs). Estimates of merchantable volume within the LSA and centre line ROW in FMD 19A rely primarily on the analysis of volume tables and / or yield curves (GNL 2005) to provide conservative estimates of volume per hectare (based on stocking). Similarly, the estimated GMV was determined by multiplying the volume per hectare by the total hectares of each forested area. Non-forested areas (e.g., fens, bogs) and disturbed areas were not used in the determination of timber volumes.

The potential Project effects on Timber Resources in each region crossed by the LSA were informed by superimposing the hypothetical 60 m wide centre line ROW on the geo-referenced (spatially delineated) inventory of forest polygons in the LSA. This spatial query produced a subset of data including an estimate of stand-level volumes, which, in turn, were aggregated to provide estimates of the GMV of all merchantable forest potentially intersected by the ROW, by region. As with the other KIs, a 20% contingency was added to the merchantable timber calculations as a precautionary approach to account for uncertainty in final Project ROW alignment selection and other Project components.

Mitigation is an integral element of the Project design and implementation. The effects assessment is based on the Project with identified mitigation in place.

12.2.4.2 Environmental Effects Descriptors

Environmental effects of the Project on each KI were described using five attributes: direction; magnitude; geographic extent; duration; and frequency; providing a comprehensive and systematic analysis (Table 12.2.4-1). Magnitude criteria are conservative and have been used in other completed and accepted environmental assessments in the province (e.g., Vale Inco Newfoundland and Labrador Limited 2008; Newfoundland and Labrador Refining Corporation 2007; Transport Canada and DFO 2007).

Table 12.2.4-1 Effects Descriptors for Vegetation Key Indicators

Effects Descriptor	Definition Regarding Key Indicator
Direction of the Effect	
Adverse	Effect is worsening or is undesirable compared with baseline conditions
Neutral	Effect is not changing compared with baseline conditions
Positive	Effect is beneficial
Magnitude	
No effect	**All KIs** Project will have no measurable effect
Low	**KIs – Vegetation Abundance and Diversity, Regionally Uncommon Plants, Timber Resources** Effect could occur to <5%[a] of the total mapped area of each Habitat Type in the LSA by region **KI – Wetland** Effect could occur to <5%[a] of the total mapped area of wetland in the LSA by region **KI – Riparian Shoreline** Effect could occur to <5%[a] of the total mapped length of riparian shoreline in the LSA by region **KI – Listed Plants** Effect could occur to <5%[b] of individual plant species of a known population
Moderate	**KIs – Vegetation Abundance and Diversity, Regionally Uncommon Plants, Timber Resources** Effect could occur to between 5% and 25%[a] of the total mapped area of each Habitat Type in the LSA by region **KI – Wetland** Effect could occur to 5% to 25%[a] of the total mapped area of wetland in the LSA by region **KI – Riparian Shoreline** Effect could occur to 5% to 25%[a] of the total mapped length of riparian shoreline in the LSA by region **KI – Listed Plants** Effect could occur to 5% to 10% of individual plant species of a known population
High	**KIs – Vegetation Abundance and Diversity, Regionally Uncommon Plants, Timber Resources** Effect could occur to >25%[a] of the total mapped area of each Habitat Type in the LSA by region **KI – Wetland** The effect could occur to >25%[a] of the total mapped area of wetland in the LSA by region **KI – Riparian Shoreline** The effect could occur to >25%[a] of the total mapped length of riparian shoreline in the LSA by region **KI – Listed Plants** Effect could occur to >10% of individual plant species in a known population
Geographic Extent	
Local	Effect will be limited to the LSA
Regional	Effect will be limited to the RSA
Beyond regional	Effect extends beyond the RSA
Duration	
Short-term	Effect will be evident for less than one year
Medium-term	Effect will be evident for between one and four years
Long-term	Effect will be evident for longer than four years, but does not extend more than 30 years
Far future	Effect will be evident throughout Project operations
Frequency	
Frequency describes how often an impact occurs and is rated as once, intermittent or continuous	

(a) As estimated by the amount intersected by a hypothetical centre line ROW (60 m wide plus a 20% contingency).

(b) Although there are no thresholds to assess the potential alteration / loss of individual listed plants or plant populations, an accepted guideline in the collection of vascular and non-vascular plant voucher specimens is that an immediate population can withstand the loss of 1 in 20 individuals or 5% of a population (Alberta Native Plant Council (ANPC) Native Plant Collection and Use Guidelines 2006, internet site).

12.2.5 Construction

12.2.5.1 Overview of Project Construction and Associated Effects Management

Potential Project interactions with Vegetation were provided in Table 12.2.3-3. Construction activities likely to result in the alteration / loss or displacement of vegetation or vegetation communities include:

- clearing of on-land portions of the transmission line ROW, including overhead wood pole connector lines between converter stations and shoreline electrode sites;
- grubbing / grading and levelling of tower foundations, access roads (both temporary and permanent), converter stations (at Muskrat Falls and Soldiers Pond), temporary camp locations, borrow pits, marshalling yards; and
- distribution of materials, including all required steel sections, hardware and conductor reels, used during tower assembly, installation and stringing of the High Voltage direct current (HVdc) powerline, including mobilization / demobilization of personnel and equipment.

Alteration / loss of vegetation and vegetation communities are the key issues for the Vegetation VEC during Construction. Vegetation alteration / loss will result from the clearing of trees and tall shrubs (i.e., in excess of 2 m height), damage (e.g., crushing) to ground vegetation, compaction of organic layers and / or loss of mineral soil substrates, changes in surface drainage patterns, and the establishment and maintenance of early successional-stage plant communities.

Non-forested vegetation communities (e.g., wetlands, low shrub) affected by the Project will remain in a relatively undisturbed state (e.g., grubbing / stripping not required). Other areas where surface vegetation is not removed, but where there may be damage to ground vegetation and / or compaction of organic layers and mineral soil substrates include temporary access roads, laydown areas, and anywhere off-road equipment traffic (e.g., nodwells, cranes) is required, if there is insufficient snow or ice cover to protect vegetation and the ground beneath. Direct effects could include physical damage or breakage of above-ground stems and buds, crushing of brittle vegetation (e.g., ground lichen), scalping or rutting of hummocky vegetation (e.g., bogs), soil compaction and admixing with effects on rooting systems, restricted water movement and reduced soil strength and structure, each contributing to decreased plant health and vigour.

Alteration or loss of vegetation can occur through the loss of living vegetation, propagules and seeds on or near the ground surface resulting from clearing, grubbing and grading of vegetation, excavation and / or burial, removal of surface organic layers and mineral soil horizons. Construction of access roads may result in loss of vegetation, physical damage to plants, soil compaction and admixing with effects on rooting systems, displaced surface horizons, exposed soil, increased erosion, water ponding, rut formation, restricted water movement and reduced soil strength and structure, each of which ultimately contribute to decreased plant health and vigour.

Project Construction may indirectly result in changes to substrate composition, moisture, and temperature (i.e., resulting from canopy removal). Where surface substrates are excavated or buried changes are anticipated (e.g., admixing), indirect alteration or loss of vegetation may occur through changes in soil moisture resulting from changes to the level (i.e., increase or decrease) of the groundwater table. Alternatively, linear disturbances may create an “edge” or the side-by-side placement of contrasting environments within an ecosystem. As such, clearing of the transmission ROW can affect vegetation in adjacent habitats through changes in the chemical and physical interactions in the environment, including light penetration, temperature, nutrient availability and snow depth or windfall. Increased access may also contribute to the spread of insects and disease, or the introduction of non-native or invasive species acting as a conduit to dispersal, with effects on distribution and abundance of native plants.

Introduction and spread of non-native and invasive species is a concern at all levels of biodiversity (i.e., landscape, community and species). Invasive species are defined by the Government of Canada (2011, internet site) as "a species of plant, animal, aquatic life or micro-organisms that outcompetes native species when introduced outside of its natural environment and threatens ecosystems, economy and society". Non-native and invasive species may be introduced in soil adhering to the equipment.

Nalcor will comply with the vegetation clearing requirements of all applicable permits and follow standard industry mitigation measures, including avoidance (e.g., wetlands, known listed plant species locations), setbacks and buffers (e.g., riparian areas) to the extent practical to limit the effects on Vegetation. Nalcor is proposing a number of Project-specific mitigation measures designed specifically to reduce potential environmental effects on vegetation, as outlined below, by KI.

Mitigation Applicable to Vegetation Abundance and Diversity

- Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands, riparian shorelines, listed plant habitats), difficult to reclaim, or of stakeholder or management concern (i.e., uncommon Habitat Types, limestone barrens).
- Existing access roads will be used and development of new access will be minimized, to the extent practical.
- Clearing activities will only occur within the ROW and other site specific areas (e.g., converter station, marshalling yards, camps).
- Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures:
  - all vegetation shall be cut within 150 mm of the surface of the ground;
  - all vegetation that exceeds 2 m height at maturity will be cut;
  - trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed;
  - all vegetation will be selectively cleared (mechanical-felling, hand-felling and piling) from the ROW to secure the transmission line; and
  - merchantable timber will be cleared through various means (e.g., feller-buncher (mechanical), hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m.
- Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats.
- A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage.
- No cutting will occur within 100 m of the centre line of a public highway without approval from the NLDNR.
- Trails will be cleared to the width of the vehicles that will use them (usually 4 m), as safety allows.
- Cleared timber will be used in the construction of corduroy bridges (i.e., logs or timber laid parallel to each other as a temporary and low impact crossing structure), where appropriate, to cross areas of saturated soils and wetland areas.
- Grubbing will not be permitted within 2 m of standing timber.
- During grubbing activities, site-appropriate erosion prevention and sediment control measures will be implemented, and could include (but not be limited to) surface water diversion ditches, silt fences, stone or brush cover, erosion control fabrics, settling ponds and other sediment filtration and flow management products.

- Grubbing will not be conducted in saturated conditions, during or immediately following a precipitation event. Where appropriate, grubbed materials will be re-spread or stockpiled and as many stumps and roots as possible will be left on the ground surface to maintain soil cohesion, to dissipate energy from run-off and promote natural revegetation.
- The length of time that grubbed areas are left exposed to natural elements will be limited to prevent unnecessary surface run-off and erosion.
- Erosion control measures including brush cover, stone riprap, wire mesh, settling ponds and drainage channels will be implemented in areas prone to soil loss.
- Topsoil stripping within or near areas with existing non-native or invasive species populations will be managed, where practical, to reduce the potential spread of these species.
- Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species.
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.
- During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.
- Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act*.
- Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel.
- Any spill will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; spills of reportable quantities of hazardous or regulated materials will be reported to the appropriate federal or provincial authority to coordinate the provincial response.
- Construction staging areas will be located and operated in a manner that limits disturbance to native vegetation to the extent practical. Unless otherwise agreed upon with the NLDEC, all construction materials and debris will be removed from marshalling yards and construction staging areas when Construction is complete, and the areas returned to original land use capability, regraded and allowed to revegetate naturally.

Mitigation Applicable to Wetlands

- Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands), and the minimum practical footprint will be used for construction activities.
- All Nalcor mitigation referencing setbacks and buffers for waterbodies will also be applied to wetlands, as appropriate.
- If construction is required in wetland areas, Nalcor will conduct the work in winter, fall, late summer, summer, spring (in order of preference), to the extent practical.
- Only construction equipment necessary to install the tower assembly within wetlands will be operated in or transported through wetlands; all other equipment will use an alternate route.
- Construction site drainage features, such as ditches, will be designed such that wetland hydrology is maintained, to the extent possible. Discharge of storm water, wastewater, or diversion of surface water

during construction will be directed away from wetlands, where practical, unless it is intended to maintain pre-construction hydrology.

- There will be no discharge of silt-laden, contaminated or nutrient-enriched water (e.g., sewage) to wetlands.
- The upper organic layer of organic material will be salvaged and stored for restoration purposes where construction is required within a wetland (e.g., if an access has to cross a wetland).
- Silt fences will be installed on all approaches to wetlands, as appropriate, to prevent erosion and sedimentation.
- To limit the potential for adverse effects from hazardous or regulated materials, use of the least toxic products will be a priority when working in and around wetlands.
- Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to designated Environmental Monitor, Construction Supervisor, or alternate point of contact for the Project.
- Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response.
- Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water.
- Refuelling and maintaining of equipment and machinery will not be permitted within 50 m of a waterbody, wetland or flood-prone area.
- Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species.
- Natural recovery will be used for wetlands in areas that are healthy and have few non-native or invasive plant species.
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.
- During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.

Mitigation for Riparian Shoreline

- Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands, riparian shorelines, listed plant habitats), difficult to reclaim, or of stakeholder or management concern (i.e., uncommon Habitat Types, limestone barrens).
- Existing trails, roads or cut-lines will be used to the extent practical to avoid disturbance to riparian vegetation and, where practical, access roads and trails will be located to avoid riparian shoreline.
- At watercourse crossings, the width of the cleared ROW will be reduced to 3 m for a minimum 15 m distance away from the shoreline. Where practical, the reduced ROW width will apply for the entire buffer zone if greater than 15 m. This could include selective cutting in these areas.
- Trails will be cleared to the width of the vehicles that will use them (usually 4 m), as safety allows.
- Trees, logs, slash, brush or debris will not be deposited in (or on, if frozen) any waterbody or disposed of within 30 m of the high water mark of any waterbody.

- Buffer zones (non-disturbance areas) of various widths around watercourses and waterbodies will be implemented as follows:
  - Approval will be obtained from the Government of Newfoundland and Labrador for development activities to take place within riparian areas in a designated PPWSA (Section 48 *Water Resources Act* 2002 (GNL 2002, internet site)); activities that could aggravate flooding or result in unmitigated adverse water quality effects will not be permitted. Development and approval will be obtained for activities to take place within a prescribed distance from the edge of a watercourse or waterbody, as follows:

Waterbody	Minimum Buffer Width
Intake lake or pond	150 m
River intake	150 m (applied 1 km upstream and 100 m downstream)
Major river channel	75 m
Major tributaries, lakes or ponds	50 m
Other waterbodies	30 m

  - In non-PPWSA, the minimum buffer zone width will be determined using the formula: 12 m + 1.5 m x slope of the land (percent) or 20 m, whichever is larger.
  - To protect scheduled salmon rivers, a minimum 30 m buffer will remain from the high water mark (DFO 2009, internet site).
- Camp plans will be reviewed prior to the commencement of Construction so that buffer zones are flagged prior to any disturbance activities.
- Approaches to fording sites will be stabilized (e.g., by use of swamp mats, corduroy), as appropriate, to avoid rutting.
- Bridges will be placed entirely above the high water mark and will not be located on meander bends, braided streams, alluvial fans, active flood plains, or any other inherently unstable area, and will be installed perpendicular to the watercourse.
- Where practical, removal of riparian vegetation will occur by hand. If machinery is required, it will be operated in a manner that minimizes disturbance to the banks of the waterbody and banks will be restored to their original or stable condition.
- Erosions control measures including brush cover, stone riprap, geotextile, settling ponds and drainage channels will be implemented in areas prone to soil loss. The length of time grubbed or otherwise disturbed areas are left exposed to natural elements will be limited to prevent unnecessary erosion.
- Blasting operations near a watercourse will be conducted in accordance with the *Guidelines for Protection of Freshwater Fish Habitat in Newfoundland and Labrador* (Gosse et al. 1998).
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.
- During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.
- Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water.
- Refuelling and maintaining of equipment and machinery will not be permitted within 50 m of a waterbody, wetland or flood-prone area.

- Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species.
- Mineral soils exposed as a result of surface disturbance within riparian areas will be allowed to re-vegetate naturally, and covered with mulch to prevent soil erosion and encourage seed germination. If there is insufficient growing season remaining, the site will be stabilized and vegetated the following spring.

Mitigation Applicable to Listed Plants and / or Regionally Uncommon Plants

- Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands, riparian shorelines, listed plant habitats), difficult to reclaim, or of stakeholder or management concern (i.e., uncommon Habitat Types, limestone barrens).
- Nalcor will adhere to federal and provincial guidelines or management plans relating to listed or regionally uncommon plants (e.g., NL Species at Risk Policy, COSEWIC Status Reports, *SARA* Recovery Strategies), unless otherwise approved by appropriate regulatory agencies.
- Nalcor will consult with NLDEC Wildlife Division regarding siting, routing or mitigation strategies for Project infrastructure in the vicinity of known listed plants or species of concern, particularly within the Northern Peninsula where a diversity of such species exists. Using information compiled by the NLDEC and LBHSP, the Project route and component sites will be selected to avoid known occurrences of individual species and their preferred habitat to the extent practical.
- Where avoidance is not possible, Nalcor, in consultation with federal and provincial regulators, will develop protection measures and environmental management techniques for listed or regionally uncommon plant species based on site-specific conditions and species sensitivity criteria.
- Qualified personnel will undertake pre-Construction plant surveys of High or Very High rated habitat (for regionally uncommon species) and important habitat (for listed plants) crossed by Project components, to identify any occurrences. Species and site-specific mitigation measures will be developed as required. The following is a list of mitigation options that may be used:
  - Align the ROW around or narrow the ROW in known locations of listed or regionally uncommon plants or their habitats to partially or completely avoid the habitat, to the extent practical.
  - Flag known locations of listed or regionally uncommon plant species within the Project components prior to construction and avoided to the extent practical. Where avoidance is not practical, other mitigation measures will be developed (e.g., transplanting) in consultation with the appropriate regulatory authorities.
  - To protect known listed or regionally uncommon plant sites that occur within Project ROWs or workspaces, clearing of vegetation in these areas will be conducted by hand and the area of disturbance will be minimized (e.g., stripping of trenchline only through limestone barrens).
  - Retain a qualified botanist to assist in the development and implementation of an appropriate mitigation strategy if any individual listed or regionally uncommon plant species is located during construction.
  - Schedule Construction activities to consider environmentally sensitive areas (i.e., limestone barrens), to the extent practical. Creation of a snow or ice cap (or other acceptable materials) to protect known listed plant sites within the ROW will be considered.
  - If appropriate for the species, seeds will be harvested or transplant material collected for reclamation of specific listed plants.
- Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species.

- Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.*
- Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel.
- Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response.
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.
- During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.

Mitigation for Timber Resources

- Nalcor will comply with existing provincial legislation and regulation (Newfoundland and Labrador *Forestry Act* 1990).
- Merchantable timber within areas supporting Project components will be cleared in accordance with provincial guidelines. Over-mature and old growth forests will be avoided, to the extent practical, during final ROW selection.
- Trails will be cleared to the width of the vehicles that will use them (usually 4 m), as safety allows.
- Where practical and feasible, timber cleared, but not intended for commercial use, will be made available for domestic use.
- Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act*.
- Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel.
- Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response.

In addition, environmental protection measures designed to limit environmental disturbances associated with Project design and construction will be detailed in a separate Environmental Protection Plan (EPP), prepared in support of the EIS.

12.2.5.2 Existing Knowledge

The primary Project interaction with Vegetation during Construction relates to the clearing of vegetative cover, similar to the surface disturbance associated with forest clearing or other linear developments (e.g., pipeline construction), which require clearing of vegetated areas. The effects of these activities on ecological processes are widely known through forest research initiatives and other similar investigations throughout the boreal forests of Canada, including Newfoundland and Labrador. A review of relevant literature is summarized in Table 12.2.5-1. It includes existing knowledge that supports the selection and effectiveness of proposed mitigation measures.

12.2.5.3 Construction Effects: Vegetation Abundance and Diversity

Degradation and alteration or loss of habitat (i.e., Habitat Types) as a result of the Project have the greatest potential to affect vegetation abundance and diversity. Changes in the abundance and diversity of vegetation could occur due to vegetation clearing, with Habitat Types altered or lost, due to disturbance from human activity, erosion, emissions and dust, and accidental spills as outlined in Table 12.2.3-3. As discussed in the Analytical Methods section, all numbers presented in this section are the value with the 20% contingency added to account for all Project components and as a precautionary approach.

The LSA reflects a conservative estimate of the area within which Project effects on each Habitat Type and Non-habitat Area could occur. Table 12.2.5-2 indicates the amount of each Habitat Type within the LSA potentially affected by Project Construction by region estimated by the centre line ROW (plus a 20% contingency). In total, for all regions, vegetation alteration or loss is estimated at 77 km^2 (4% of the total LSA). By region, vegetation alteration or loss as a result of surface disturbance is an estimated at 28 km^2 (4% of the LSA) within Central and Southeastern Labrador; 18 km^2 (4% of the LSA) within the Northern Peninsula; 24 km^2 (4% of the LSA) within Central and Eastern Newfoundland; and 8 km^2 (4% of the LSA) within the Avalon Peninsula.

Table 12.2.5-1 Existing Knowledge (Construction): Vegetation

Reference	Study / Project Context	Summary of Findings
Dube et al. (2011)	*Do power line rights-of-way facilitate the spread of non-peatland and invasive plants in bogs and fens?* Studied the role of power line ROWs in the spread of undesirable species to peatlands	– Sampled vegetation communities within and adjacent to power line ROWs in 23 bogs and 11 fens in southern Quebec. – In fens, invasive species were found in the first 250 m within ROWs, while native non-peatland species were able to spread into entire ROWs. – Invasive species in adjacent fen habitats were mostly limited to the first 4 m from ROW edges, but some species were able to establish at more than 43 m from ROWs. – Invasive species were mostly restricted to the first 31 m within ROWs intersecting a bog and almost none dispersed in the adjacent bog habitats. – The average cover of invasive species in ROWs was related to intrinsic abiotic conditions (e.g., water pH, water conductivity, and water table level). – Landscape and historical variables such as how long ago the ROW was constructed had little influence on spread of invasive species in both bogs and fens.
Environment Canada (2010a)	*Management Plan for the Boreal Felt Lichen – Boreal Population (Erioderma pendicellatum) in Canada* Focuses on the identification of “important habitat” (unlike that defined for critical habitat under *SARA*) for protection of the species; however, also notes the continued lack of understanding regarding forest types required for the Boreal Felt Lichen life cycle	– Identifies various threats to the population including natural stressors (i.e., stand senescence, blowdown, insect outbreaks) and anthropogenic disturbance (i.e., wood harvesting, development, fire, pesticides). – Identifies transition areas around wetlands (i.e., bogs) as important (within its known range) to boreal felt lichen and recommends that buffers of these habitats increase from 5 m to encompass the entire transition area. – Information gaps also exist for restoration of the species, particularly related to protocols for transplantation and habitat suitability.

Table 12.2.5-1 Existing Knowledge (Construction): Vegetation (continued)

Reference	Study / Project Context	Summary of Findings
Forest Invasives Leadership Team (FILT) (2009)	*Invasive Species Best Management Practices for the Transportation and Utility Rights-of-Ways in Wisconsin* Outlines Best Management Practices related to soil disturbance, vegetation management and inspection / monitoring, transport of materials and revegetation and landscaping	– Creation and upkeep of transportation and utility corridors results in soil and vegetation disturbance, along with the movement of people and vehicles, which contribute to the spread of invasive species. – Stabilizing disturbed soil as soon as possible is crucial to prevent the germination and growth of invasive species. – Early detection and rapid response are an important part of managing invasive species. – Monitoring sites after activities may detect new or re-invasions early and help to evaluate the success of invasive species control efforts. – Site specific revegetation should address site preparation, species selection, and overall maintenance of the area.
Newfoundland and Labrador Hydro (2008, internet site)	*Environmental Performance Report 2008*	– Newfoundland and Labrador Hydro owns and operates transmission and distribution line facilities on the Northern Peninsula of Newfoundland. – Some of these facilities coincide with environments (i.e., limestone barrens habitat) known to contain listed plants (e.g., Barrens willow, Fernald's braya and Long's braya) protected by *SARA* and *NLESA.* – To ensure protection of listed species, Newfoundland and Labrador Hydro have contributed to the development of re-introduction protocols with potential to avoid and / or reduce potential effects to these plants and their habitats. – Since 2008, Nalcor has partnered with the Memorial University of Newfoundland Botanical Gardens (MUNBG) in an effort to develop specific strategies related to the protection of listed plants occupying the limestone barren habitats of the Northern Peninsula. – Nalcor has supported MUNBG on a number of initiatives, including the establishment and maintenance of an ex situ program at MUNBG, the deposition of Long's and Fernald's braya seed in the national seed bank and other participating institutions, the creation of public awareness of the protected areas and, lastly, through the development of re-introduction protocols for these species, and collaborative efforts with Recovery Team members on the restoration of degraded sites known to contain listed species.

Table 12.2.5-1 Existing Knowledge (Construction): Vegetation (continued)

Reference	Study / Project Context	Summary of Findings
DFO (2007, internet site)	*Newfoundland and Labrador Operational Statement, Overhead Line Construction* Outlines requirements for constructing overhead lines near riparian and wetland habitats based on observed environmental effects	– Operational Statement focuses on riparian vegetation that occurs adjacent to the watercourse and directly contributes to fish habitat by providing shade, cover and spawning and food production areas. – Priority measures to protect riparian areas (which protect fish habitat) when constructing overhead lines are recommended, as follows: o Installation completed during frozen conditions, or using a helicopter. o Approaches constructed perpendicular to watercourses to minimize riparian alteration / loss. o Avoidance of the riparian areas of meander bends, braided streams, alluvial fans, active floodplains or any other area that is inherently unstable for the locations of structures. o Location of all structures above the high water mark where possible. o Minimization of vegetation removal / maintenance in riparian areas.
Newfoundland and Labrador Riparian Working Group (NLRWG) (2007)	*Options for Managing Riparian Habitat during Forestry Operations* Presents options for managing riparian shoreline during forest operations based on effects of different buffer sizes and forest cover	– Buffer width of <20 m for forestry (clearing) operations found to be insufficient to prevent siltation into waterbodies. – Unless riparian buffer edges adjacent to cleared areas are managed, there will be potential for blowdown.

Table 12.2.5-1 Existing Knowledge (Construction): Vegetation (continued)

Reference	Study / Project Context	Summary of Findings
Hansena and Clevenger (2005)	*The influence of disturbance and habitat on the presence of non-native plant species along transport corridors* Study compared the frequency of non-native plant species along highways and railways, specifically comparing ability of non-native species to colonize grasslands versus dense forests along the corridors	– Altered disturbance regime in plant communities along corridor edges and vehicle traffic can facilitate the spread and establishment of invasive non-native plant species. – Measured the frequency of several non-native plant species from the edge of highways and railways in grasslands and forests, as well as at control sites. – Both transportation corridors had higher frequency of non-native species than control site. – Grasslands had higher frequency of non-native species than forested habitats, but the frequency did not differ between the highways and the railways. – In grasslands along highways and railways, frequency of non-native species was higher than at control sites up to 150 m from the corridor edge, whereas for forested habitats frequency was only higher than control sites up to 10 m from the corridor edge. – Results suggest that corridor edges and grassland habitats act as microhabitats for non-native species and are more prone to invasion than forests, especially if disturbed.
Trombulak and Frissell (1999, internet site)	*Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities*	– Reviewed scientific literature on the ecological effects of roads and concluded that they are typically associated with negative effects on biotic integrity in both terrestrial and aquatic ecosystems. – Identifies seven general ways that roads affect terrestrial and aquatic ecosystems, with direct and indirect effects to vegetation occurring through: disruption of the physical environment; alteration of the chemical environment; spread of exotic species; and changes in human use of land and water. – Suggests that roads have diverse and systemic effects on many aspects of terrestrial and aquatic ecosystems and that the ecological effects resonate substantial distances from the road in terrestrial ecosystems, creating habitat fragmentation and facilitating human exploitation. – Recommends that road design, management and restoration be carefully tailored to address the full range of ecological processes that may be affected – Concludes that it is unlikely to fully mitigate the effects of roads.

Table 12.2.5-1 Existing Knowledge (Construction): Vegetation (continued)

Reference	Study / Project Context	Summary of Findings
Angold (1997)	*The impact of a road upon adjacent heathland vegetation: effects on plant species composition*	– The effect of a road upon heathland vegetation was investigated at five sites adjacent to the main trunk road in the UK. – Enhanced growth of vascular plants, notably heather and grass species near the road was observed and attributed to the increase in oxides of nitrogen from vehicle exhaust. – An increase in the abundance of grasses in the heathland near roads was observed, probably due to the changes in relative competitive ability of plant species under conditions of eutrophication. Alternatively, there was a decrease in the abundance and health of lichens near the road. – The extent of the edge effect in the heath was closely correlated with the amount of traffic carried by the road, with a maximum edge effect of 200 m adjacent to a dual carriageway. – Recommends mitigation including the use of buffer zones to protect oligotrophic communities or other measures to minimize the pollution input from vehicle exhausts to environmentally sensitive areas.
Farmer (1993)	The effects of dust on vegetation – a review	– Effects of dust on crops, grasslands, heathlands, trees and woodlands, arctic bryophyte and lichen communities are identified. – Found that dust deposition may affect photosynthesis, respiration, transpiration and allow the penetration of phytotoxic gaseous pollutants in vegetation. – Visible injury symptoms may occur and generally there is decreased productivity. – Suggests that most plant communities are affected by dust deposition so that community structure is altered. – Identifies epiphytic lichens and sphagnum moss dominated communities as the most sensitive of those studied.

Table 12.2.5-1 Existing Knowledge (Construction): Vegetation (continued)

Reference	Study / Project Context	Summary of Findings
Nickerson et al. (1989)	*Effects of Power-Line Construction on Wetland Vegetation in Massachusetts, USA* Documents the effects of power utility ROW construction and maintenance on vegetation in a wooded swamp, cattail marsh and shrub bog in northern Massachusetts	– Cattail marsh vegetation recovery was complete one year following disturbance. – Wooded swamp vegetation recovered within two years of disturbance. – Recovery of shrub bog vegetation was incomplete 10 years after disturbance, reflecting the relative sensitivity of this wetland type to disturbance due to soil structure, nutrient limitations, and a dominance of woody vegetation. – Construction did not occur exclusively in winter.
MacLellan and Stewart (1986)	*Latitudinal Gradients in Vegetation Along a Disturbed Transmission Corridor right-of-way in Manitoba* Presents the results of a floristic survey conducted along an HVdc transmission line ROW extending over 895 km, from 50° to 56° N latitude, and intersecting six of the natural vegetation zones in Manitoba	– The establishment and spread of non-native and invasive species in powerline corridors are facilitated by several factors such as the increase in light intensity and temperature owing to the eradication of tall indigenous species. – The construction and Operations and Maintenance of these linear structures and their associated ROWs may therefore have adverse effects on vegetation by acting as dispersal mechanism for non-native and invasive plant species.
Thibodeau and Nickerson (1986)	*Impact of Power Utility Rights-of-Way on Wooded Wetland* Documents the effects of power utility ROW construction on vegetation in a wooded swamp in northern Massachusetts	– Except for differences in size and maturity, vegetation recovered within two years of construction. – Construction occurred in winter.
Grigal (1985)	*Impact of right-of-way Construction on Vegetation in the Red Lake Peatland, Northern Minnesota* Evaluation of construction effects on vegetation in a large northern Minnesota peatland following transmission ROW construction	– All vegetation strata, except trees, demonstrated recovery by the second growing season following construction, which occurred in the winter on frozen soils and dormant vegetation.

Table 12.2.5-2 Habitat Types and Non-habitat Areas Crossed by the Centre Line ROW within the LSA, By Region (Includes 20% Contingency)

	Central and Southeastern Labrador		Northern Peninsula		Central and Eastern Newfoundland		Avalon Peninsula		Total Area (km^2) of Habitat Type within LSA (Percent of Entire LSA (%))	Total Area (km^2) of Habitat Type within ROW (Percent of Entire LSA (%))
	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))		
Habitat Types										
Alpine Vegetated	0 (0)	0 (0)	1 (<1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (<1)	0 (0)
Black Spruce Lichen Forest	15 (2)	1 (<1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	15 (1)	<1 (0)
Burn	5 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (<1)	<1 (0)
Conifer Forest	197 (26)	7 (1)	135 (28)	5 (1)	41 (6)	1 (<1)	13 (5)	0 (0)	386 (18)	14 (1)
Open Conifer Forest	19 (25)	8 (1)	86 (18)	3 (1)	88 (13)	3 (1)	0 (0)	0 (0)	368 (17)	14 (1)
Conifer Scrub	154 (25)	6 (1)	7 (2)	0 (0)	20 (3)	1 (<1)	0 (0)	0 (0)	182 (8)	7 (<1)
Cutover	0 (0)	0 (0)	23 (5)	1 (<1)	106 (16)	4 (1)	25 (10)	0 (0)	154 (7)	5 (<1)
Hardwood Forest[(a)]	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Table 12.2.5-2 Habitat Types and Non-habitat Areas Crossed by the Centre Line ROW within the LSA, By Region (Includes 20% Contingency) (continued)

	Central and Southeastern Labrador		Northern Peninsula		Central and Eastern Newfoundland		Avalon Peninsula		Total Area (km^2) of Habitat Type within LSA (Percent of Entire LSA (%))	Total Area (km^2) of Habitat Type within ROW (Percent of Entire LSA (%))
	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))		
Lichen Heathland[(a)]	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Kalmia Lichen/ Heathland	44 (6)	1 (<1)	1 (<1)	0 (0)	8 (1)	0 (0)	15 (6)	1 (<1)	68 (3)	2 (0)
Mixedwood Forest	3 (<1)	0 (0)	36 (7)	1 (<1)	214 (33)	8 (1)	49 (20)	1 (<1)	303 (14)	11 (1)
Rocky Barrens	0 (0)	0 (0)	0 (0)	0 (0)	1 (<1)	0 (0)	16 (7)	1 (<1)	18 (1)	1 (0)
Scrub / Heathland / Wetland Complex	0 (0)	0 (0)	108 (22)	4 (1)	74 (11)	3 (<1)	99 (40)	4 (2)	281 (14)	11 (1)
Wetland	145 (19)	4 (1)	39 (8)	1 (<1)	83 (13)	3 (<1)	7 (7)	0 (0)	274 (13)	8 (1)

Table 12.2.5-2 Habitat Types and Non-habitat Areas Crossed by the Centre Line ROW within the LSA, By Region (Includes 20% Contingency) (continued)

	Central and Southeastern Labrador		Northern Peninsula		Central and Eastern Newfoundland		Avalon Peninsula		Total Area (km^2) of Habitat Type within LSA (Percent of Entire LSA (%))	Total Area (km^2) of Habitat Type within ROW (Percent of Entire LSA (%))
	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within LSA (Percent of LSA by region (%))	Total Area (km^2) of Habitat Type within the ROW (Percent of LSA by region (%))		
Non-Habitat Areas										
Cloud / Shadow	0 (0)	0 (0)	7 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	7 (<1)	<1 (0)
Exposed Earth / Anthropogenic / Cutblock	0 (0)	0 (0)	2 (<1)	0 (0)	3 (<1)	0 (0)	2 (<1)	0 (0)	8 (<1)	<1 (0)
Exposed Earth / Anthropogenic	0 (0)	0 (0)	1 (<1)	0 (0)	1 (<1)	0 (0)	5 (2)	0 (0)	7 (<1)	<1 (<1)
Open Water	12 (2)	0 (0)	37 (8)	0 (0)	14 (2)	0 (0)	16 (6)	0 (0)	79 (4)	<1 (<1)
Total	**770 (100)**	**28 (4)**	**485 (100)**	**18 (4)**	**654 (100)**	**24 (4)**	**248 (100)**	**8 (4)**	**2,156 (100)**	77 (4)

Note: Rounding errors less than 1% may occur in the totals. ROW calculations include the 20% contingency.
(a) Refers to Habitat Types originally identified within the RSA, although absent from the LSA.

Existing, undisturbed Habitat Types cover approximately 2,055 km^2 or 94% of the LSA. The Project will likely result in the alteration of 77 km^2 (4%) of available Habitat Types within the LSA (Table 12.2.5-2). Construction activity associated with clearing the ROW and other Project components (including 20% contingency) will likely disturb from 0% to 8% of the current area of each Habitat Type within the LSA (Table 12.2.5-3). Based on landmass or extent of land area affected, Habitat Types most affected by Construction are likely to be Conifer Forest and Open Conifer Forest, each with potential losses of 14 km^2. When considered on a percentage basis, the largest effect will be experienced by the Black Spruce Lichen Forest and Rocky Barren Habitat Types, with 8% and 7% (including the 20% contingency) of the available habitat potentially altered / lost, respectively.

Post-Construction, the actual area of Habitat Types affected will likely be lower than that identified in Table 12.2.5-2 as this table represents the total area of each Habitat Type present within the centre line ROW, and does not take into account Nalcor's commitment to minimize disturbance to those Habitat Types that would not typically require additional ROW clearing (i.e., Burn, Conifer Scrub, Lichen Heathland, Kalmia / Lichen Heathland, Rocky Barren, Cutover) and to avoid sensitive areas (i.e., Wetlands), where feasible.

In relation to the amount of area available within the LSA, a small number of Habitat Types, referred to as uncommon Habitat Types, individually occupy <1% of the total land area within the LSA (Table 12.2.5-2). Within the transmission corridor, uncommon Habitat Types, include Black Spruce Lichen Forest (1%), Burn (<1%), Alpine Vegetated (<1%) and Rocky Barrens (1%). These Habitat Types are typically patchily distributed and / or located within a narrow geographic range (e.g., Black Spruce Lichen Forest). Collectively, they comprise a total area of 39 km^2 or 2% of the LSA. The estimated alteration / loss of uncommon Habitat Types as a result of the Project is estimated at less than 2 km^2 or <0.1% of the total LSA, based on the centre line ROW.

Relative to the area occupied by these uncommon Habitat Types in the RSA, Black Spruce Lichen Forest occurs only within Central and Southeastern Labrador, occupying 15 km^2 of the 128 km^2 (12%) of the available habitat within the RSA, by region. Similarly, Alpine Vegetated Habitat Types are primarily restricted to the Long Range Barrens Ecoregion of the Northern Peninsula region, occupying <1% of the total area of the LSA and 3% of the mapped area (27 km^2) within the RSA. Within the LSA, Burn Habitat Types were identified in Labrador and Newfoundland (i.e., Central and Eastern Newfoundland and Avalon Peninsula regions), occupying 5 km^2 of 53 km^2 (9%) of the available habitat within the RSA. Alternatively, Rocky Barrens do not occur in Labrador, but contribute to 18 km^2 (21%) of the 84 km^2 available within the RSA for all geographic regions occupied by this Habitat Type in Newfoundland. This demonstrates that the uncommon Habitat Types will still be represented within the RSA following the Project.

To provide an estimation of the extent of vegetation alteration / loss likely to occur within the LSA, information from Table 12.2.5-2 was used to calculate the proportion of each Habitat Type present at baseline (current conditions) and at post-Construction. Likely change in Habitat Types as a result of the Project, in terms of area and as a proportion of the LSA, is summarized in Table 12.2.5-3.

Although Table 12.2.5-3 suggests that there is a loss of vegetation, the majority of Project effects from clearing of the ROW are anticipated to result in structural stage changes to forested Habitat Types (i.e., Black Spruce Lichen Forest, Conifer Forest, Open Conifer Forest, Hardwood Forest and Mixedwood Forest). Habitat Types currently characterized by forest vegetation in the late successional stages of stand development will be altered to a condition that promotes the growth and maintenance of early successional stage Habitat Types (i.e., Burn, Conifer Scrub, Lichen Heathland, Kalmia / Lichen Heathland, Cutover).

In summary, based on data provided in Table 12.2.5-2 and Table 12.2.5-3 and assuming the centre line ROW, including the 20% contingency, the Project is likely to affect low proportions of each Habitat Type within any given region. The total percentage of Habitat Types affected is approximately 3% (range 0% to 8%) of the total LSA. Thus, while the Project will alter the distribution and abundance of each Habitat Type crossed (e.g., alteration to an early successional stage or loss), all Habitat Types will continue to be represented in the LSA following Project Construction.

Table 12.2.5-3 Potential Change to Habitat Types within the LSA

Habitat Type and Non-Habitat Areas	Baseline		Post-Construction		Centre Line ROW	
	Area of Habitat Type within the LSA (km^2)	% of Total LSA Area	Area of Habitat Type within the LSA (km^2)	% of Total LSA Area	Area of Habitat Type within the LSA (km^2)	% Change in Habitat Type
Habitat Types						
Alpine Vegetated	1	0	0	0	0	0
Black Spruce Lichen Forest	15	1	14	1	0	-8
Burn	5	0	5	0	0	0
Conifer Forest	386	18	374	17	14	-4
Open Conifer Forest	368	17	356	17	14	-4
Conifer Scrub	182	8	176	8	7	-4
Cutover	154	7	150	7	5	-4
Hardwood Forest[(a)]	0	0	0	0	0	0
Lichen Heathland[(a)]	0	0	0	0	0	0
Kalmia Lichen / Heathland	68	3	66	3	2	-4
Mixedwood Forest	303	14	294	14	11	-4
Rocky Barrens	18	1	17	1	1	-7
Scrub / Heathland / Wetland Complex	281	13	272	13	11	-4
Wetland	274	13	267	12	8	-4
Subtotal	*2,055*	*94*	*1,992*	*92*	*74*	*3*
Non-Habitat Areas						
Subtotal	*101*	*5*	*100*	*5*	*1*	*-1*
Total	**2,156**		**2,091**		**77**	

Note: Rounding errors less than 1% may occur in the totals. Centre line calculations include the 20% contingency.
(a) Refers to Habitat Types originally identified within the RSA, although absent from the LSA.

There is potential for the establishment of non-native and invasive species within all Habitat Types as a result of construction. Seeds and propagules may be transported on vehicles and equipment, and disturbance of adjacent areas creates changes in the local environmental conditions (e.g., light availability, temperature, air flow) that facilitates the establishment of new plants. The proposed mitigation measures will limit the potential for the introduction and establishment of non-native and invasive species in previously undisturbed areas. Due to the remote nature of the majority of the LSA, the local abundance of seeds and propagules for introduction to areas affected by the Project is expected to be low.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on vegetation abundance and diversity may result in alteration / loss of Habitat Types. Considering that these events would occur within disturbed areas (e.g., ROW) and would be limited, the proposed mitigation will likely limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental release of hydrocarbons or other contaminants from spills or leaks may result in alteration / loss of Habitat Types during Project Construction. Accidental releases of hydrocarbons or other contaminants may occur during the fuelling or operation of vehicles or machinery, and are likely to be small (less than 30 L). The presence of contaminants may result in vegetation and soil bacteria mortality in natural habitats. The remediation of a spill would likely require the excavation and disposal of contaminated soils, resulting in a direct loss of vegetation. The proposed mitigation measures will limit the likelihood of a release of hydrocarbon or other contaminant into the natural environment and limit the extent of contamination to existing Habitat Types.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Vegetation Abundance and Diversity are as follows:

- Adverse because:
  - Project Construction could result in the alteration / loss of up to 77 km^2 of mapped Habitat Types in the LSA, as well as a potential reduction in health of vegetation due to erosion, emissions, dust and the competitive exclusion of natural vegetation or vegetation communities due to introduction and spread of non-native and invasive species.
- Of low magnitude because:
  - Estimated alteration / loss of the majority of Habitat Types is <5%. Construction will likely affect a small portion (range 0% to 8%) of total available Habitat Types, and thus, Vegetation Abundance and Diversity, in the LSA. Two Habitat Types, Black Spruce Lichen Forest (8%) and Rocky Barren (7%), will exceed the identified magnitude criteria for low (i.e., <5% of a total mapped area); however, considering the nature of disturbance to these Habitat Types, their availability in the RSA, and the implementation of mitigation the magnitude of the effect will also be low.
  - None of the Habitat Types (i.e., those recognizable at a landscape level) affected by the Project are unique or limiting in Newfoundland and Labrador and the Project will not result in adverse effects on diversity.
  - At the end of the Construction phase, the ROW will remain in a vegetated albeit altered condition (i.e., varied structural stage development) with losses of vegetation related to Project components such as access roads and converter stations.
  - Accidents, spills, or malfunctions during construction would likely be small and affect a limited area.
- Local to regional because:
  - Effects are primarily confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.
- Of far future duration because:
  - Effects are expected to extend beyond the Construction phase, extending throughout the life of the Project. In addition, slow growing conditions, including cold, nutrient-poor substrates and generally thin soils associated with some geographic regions (e.g., Central and Southeastern Labrador and portions of the Northern Peninsula) or Habitat Types will limit regeneration potential.
  - Access to the ROW will be required throughout the life of the Project.

The effect of Project Construction on Vegetation Abundance and Diversity is constant over the four-year construction period and will be measurable for the life of the Project.

There is a high degree of confidence that the effect on Vegetation Abundance and Diversity will not be greater than predicted because of the level of knowledge related to the existing environment and the known effects of Construction on the types of vegetation likely affected by the Project. Vegetation mapping of the RSA / LSA was based on remote-sensing-based mapping information (Stantec 2011a; Stantec 2010b), providing the necessary background from which the systematic, consistent identification and delineation of large-scale vegetation patterns were evaluated. Baseline field surveys were also completed throughout the LSA to verify and improve the accuracy of the Habitat Type mapping. Additionally, the 20% contingency to compensate for the final ROW alignment and other Project components ensures that a precautionary approach has been taken when estimating the effects of the Project on vegetation abundance and diversity.

12.2.5.4 Construction Effects: Wetlands

The following section discusses the likely effects of Project Construction on Wetlands, by region. The extent of Project interactions with wetlands were evaluated with respect to wetland loss (conversion to upland, lake, pond or watercourse) or alteration (changes in wetland class, form or function), and considers direct and indirect effects. Where for technical reasons avoidance is not possible, wetland loss may occur during Project Construction as a direct result of infilling for Project components (e.g., the footprint of a tower foundation or roadbed).

Wetland alteration may occur where mitigation measures minimize, but may not completely eliminate the effects of Project Construction (e.g., minor hydrological changes adjacent to an access road or structure). Minor alteration may also occur as a result of the introduction and establishment of non-native and invasive species in undisturbed wetlands adjacent to the ROW, as demonstrated by Dube et al. (2011). As the Project Construction progresses, some new areas will be made accessible for OHV access which may result in additional disturbance opportunities. It is important to note that much of the transmission corridor crosses areas of existing access (e.g., paralleling the TLH3 and other access roads and highways, twinning existing transmission lines (see Chapter 3, Appendix 3-2). Accidental spills and malfunctions may also result in wetland alteration / loss. The introduction of harmful substances (e.g., a fuel spill) may cause vegetation mortality, and subsequent remediation of an accidental spill may require direct soil and vegetation removal.

Nalcor will limit the alteration / loss of wetland habitat to the extent practical by routing of the ROW to avoid wetlands where feasible. Final route selection and design will be informed by pre-engineering and geotechnical studies and environmental considerations. For both structural and environmental reasons, these studies will include confirmation of the extent of wetland peat occurrence. Where for technical reasons it is not possible to avoid intersecting wetlands, alteration or loss will be minimized through implementation of mitigation measures discussed previously. The following sections evaluate the wetland habitat area crossed by the hypothetical 60 m wide centre line ROW to inform the assessment. This is based on an estimate of the number of wetlands, by CWCS class and form (NWWG 1997) potentially crossed by the Project.

Central and Southeastern Labrador

Approximately 2% (2 km^2) of the total delineated wetland habitat within the LSA in Central and Southeastern Labrador intersects the centre line ROW (Table 12.2.5-4). All wetlands potentially affected by the Project in this region are peatlands (i.e., bogs, fens and their complexes), which occur commonly throughout Newfoundland and Labrador (Wells and Hirvonen 1988). The proportion of peatlands within the centre line ROW compared to the amount available in the LSA ranges from 0% to 10% for each peatland form. The wetland form with the highest proportion of area within the centre line ROW is slope bog / ribbed fen (10% or <1 km^2).

Although average wetland density (0.6 wetlands / km^2), size (0.13 km^2), and presence (9% of landmass) in the Central and Southeastern Labrador region is moderate compared to other regions of the LSA, the distribution of wetlands is irregular. Wetland density and presence is low in the south-eastern and north-western extents of the region which means wetland avoidance is likely practical. Further, the portion of the LSA that approaches Muskrat Falls parallels the existing TLH3 which is an existing disturbance corridor. In some of the central portions of the LSA in this region, wetland density and presence is much higher and opportunities for avoidance are less.

Table 12.2.5-4 Proportion of Wetland Area in Central and Southeastern Labrador Intersected by the LSA and Centre Line ROW, by Wetland Class and Form

Wetland Type		Wetland Area	Wetland Area Intersected by the Centre Line ROW (km^2)[a]	Proportion of Wetland Area Within the LSA Intersected by the Centre Line ROW (%)[a]
Wetland Class	Wetland Form	Within LSA (km^2)		
Bog	Plateau	2	<1	5
	Slope	12	<1	3
	String	14	<1	2
	Domed	1	—	—
	Ribbed	<1	—	—
	Blanket	<1	—	—
Fen	Ribbed	1	<1	5
	String	<1	—	—
	Domed	<1	—	—
	Slope	5	<1	4
Peatland Complex	Raised bog-slope fen	<1	—	—
	Ribbed fen-slope fen	16	<1	3
	Domed bog-slope bog	<1	—	—
	Slope bog-ribbed fen	<1	<1	10
	Raised bog-slope fen	1	<1	3
	Plateau bog-string bog	10	<1	1
	String bog-ribbed fen	7	<1	3
	String bog-slope bog	<1	—	—
Total		**69**	**2**	**2**

Note: Rounding errors less than 1% may occur in the totals.
— Represents zero values.
[a] Includes 20% contingency.

Northern Peninsula

Approximately 3% (1 km^2) of the wetland habitat area within the LSA in the Northern Peninsula intersect the centre line ROW (Table 12.2.5-5). Approximately 1 km^2 of riparian marsh habitat occurs in the LSA in this region. The Northern Peninsula supports the highest occurrence of this wetland type (according to the ELC (Stantec 2010b)), which provides high botanical productivity, contributes to water quality improvement in the watershed, manages storm water and provides high quality habitat for waterfowl (Stantec 2010c). The riparian marsh wetland type will be prioritized for avoidance due to its paucity and its high value compared to peatlands. The centre line ROW intersects approximately 1% of the 1 km^2 of this wetland class in the LSA.

Table 12.2.5-5 Proportion of Wetland Area on the Northern Peninsula Intersected by the LSA and Centre Line ROW, by Wetland Class and Form

Wetland Type		Wetland Area	Wetland Area Intersected by the Centre Line ROW (km^2)[a]	Proportion of Wetland Area Within the LSA Intersected by the Centre Line ROW (%)[a]
Wetland Class	**Wetland Form**	**LSA (km^2)**		
Bog	Plateau	11	<1	4
	Slope	11	<1	3
	Domed	1	<1	4
	Ribbed	2	–	–
Fen	Ribbed	<1	<1	<1
	Slope	1	<1	6
Marsh	Riparian	1	<1	1
	Basin	<1	—	—
Peatland Complex	Domed bog-ladder fen	1	—	—
	Domed bog-ladder fen-slope fen	<1	—	—
	Domed bog-slope fen	1	—	—
	Ribbed fen-slope fen	1	<1	8
	Domed bog-slope bog	<1	<1	2
	Slope bog-ribbed fen	7	<1	4
	Plateau bog-ribbed fen	3	<1	3
	Plateau bog-slope bog	2	<1	2
	Plateau bog-slope fen	1	<1	4
Total		**44**	**1**	**3**

Note: Rounding errors less than 1% may occur in the totals.
— Represents zero values.
[a] Includes 20% contingency.

The proportion of peatlands (i.e., bogs, fens, and their complexes) in the LSA that intersect with the centre line ROW in the Northern Peninsula ranges from 0% to 8%. The wetland form with the highest proportion of area intersecting with the centre line ROW is the ribbed fen / slope fen complex (8% or <1 km^2).

In the Northern Peninsula, average wetland density (0.7 wetlands / km^2), size (0.15 km^2), and presence (9% of landmass) is moderate compared to the other regions of the LSA. The pattern of density is irregular, and wetlands are likely more easily avoided during routing in some portions of the LSA, whereas in others, wetland density may make avoidance difficult. Wetlands do not occur in the southern-most extent of this region or within discrete 20 km segments throughout this portion of the LSA. Conversely, the northern-most extent, and several 10 km to 20 km segments of the LSA have high densities of wetlands.

Central and Eastern Newfoundland

Approximately 3% (2 km^2) of wetland habitat delineated within the LSA in Central and Eastern Newfoundland intersects the centre line ROW (Table 12.2.5-6). This amount represents the estimated amount of wetland habitat potentially affected by Project Construction, and will be avoided to the extent practical. Peatlands (bogs, fens, and their complexes) are the only wetland type crossed by the centre line ROW in this region. The wetland form with the highest proportion of area intersecting with the centre line ROW is slope bog-ribbed fen (4% or 1 km^2). Peatlands are abundant in Newfoundland (Wells and Hirvonen 1988).

Wetland average density in Central and Eastern Newfoundland was 135% higher than in any other region (1.1 wetlands/km^2) and wetland presence accounted for 12% of the land mass. This density is regular throughout this region, with few short intervals (<20 km) of low wetland density areas.

Table 12.2.5-6 Proportion of Wetland Area in Central and Eastern Newfoundland Intersected by the LSA and Centre Line ROW, by Wetland Class and Form

Wetland Type		Wetland Area	Wetland Area Intersected by the Centre Line ROW (km^2)[(a)]	Proportion of Wetland Area Within the LSA Intersected by the Centre Line ROW (%)[(a)]
Wetland Class	Wetland Form	LSA (km^2)		
Bog	Slope	7	<1	4
	Domed	7	<1	2
	Basin	<1	<1	<1
Fen	Ladder	<1	—	—
	Ribbed	13	<1	3
	Domed	<1		
	Slope	13	<1	4
Marsh	Riparian	<1	—	—
Peatland Complex	Domed bog-ladder fen	6	<1	2
	Domed bog-ladder fen-slope fen	6	<1	3
	Domed bog-ribbed fen	2	—	—
	Domed bog-slope fen	5	<1	3
	Ribbed fen-slope fen	5	<1	3
	Slope bog-ribbed fen	13	1	4
Total		**76**	**2**	**3**

Note: Rounding errors less than 1% may occur in the totals.
— Represents zero values.
(a) Includes 20% contingency.

Avalon Peninsula

Approximately 4% (1 km^2) of wetland habitat area within the LSA on the Avalon Peninsula is intersected by the centre line ROW, representing an estimate of the potential amount to be affected by Project Construction (Table 12.2.5-7). Peatlands (bogs and bog / fen complexes) are the only wetland classes within the LSA. Domed bogs and slope bogs are the only wetland class that intersect the centre line ROW in this region.

Table 12.2.5-7 Proportion of Wetland Area on the Avalon Peninsula Intersected by the LSA and Centre Line ROW, by Wetland Class and Form

Wetland Type		Wetland Area	Wetland Area Intersected by the Centre Line ROW (km^2)[(a)]	Proportion of Wetland Area Within the LSA Intersected by the Centre Line ROW (%)[(a)]
Wetland Class	**Wetland Form**	**LSA (km^2)**		
Bog	Slope	13	<1	4
	Domed	2	<1	4
	Basin	<1	—	—
Peatland Complex	Domed bog-slope bog	6	<1	4
	Slope bog-ribbed fen	<1	—	—
Total		**21**	**1**	**4**

Note: Rounding errors less than 1% may occur in the totals.
— represents zero values.
(a) Includes 20% contingency.

Average wetland size (0.10 km^2), density (0.8 wetlands / km^2) and presence (8% of the LSA) are low in the Avalon Peninsula compared to other regions of the LSA. The distribution of wetlands is irregular, with the majority of the region having low wetland density (less than 0.3 wetlands per km^2). Three discrete sections between 15 and 30 km in length have comparatively high wetland density. Any unavoidable alteration / loss will be minimized through implementation of the mitigation discussed above.

Summary

The proportion of wetland habitat in the entire LSA with the potential to be exposed to Project effects (i.e., estimated by the intersection with the centre line ROW) is likely low, approximately 3% (total of 6 km^2) (Table 12.2.5-8). This wetland habitat will be avoided by Nalcor to the extent practical, and where effects occur, appropriate mitigation will be employed in a proactive manner.

There is potential for the establishment of non-native and invasive species in peatlands intersected by and adjacent to the ROW. This may occur as a result of non-native and invasive seeds and propagules transported to peatlands from other regions on construction vehicles and equipment during Project Construction. The wet, low pH and low nutrient conditions in bogs tend to limit the establishment of non-native and invasive species in this wetland class. Dube et al. (2011) found that invasive species establishment was restricted to the first 31 m of ROW intersected bogs, and almost none were found in bogs adjacent to a ROW in Quebec. The comparatively higher nutrient availability and moderate pH typical to fen class wetlands is less limiting to the establishment of invasive species. Dube et al. (2011) found invasive species within the first 250 m of ROW intersected fens, and invasive species up to 43 m away from the ROW in fens adjacent to the ROW. Native, non-peatland species were able to spread to the entire ROW, suggesting that peatlands are at a lower risk of alteration from non-native, invasive species introduction than adjacent uplands.

Table 12.2.5-8 Proportion of Wetland Area in the LSA for the Project Intersected by the LSA and Centre Line ROW, by Wetland Class and Form

Wetland Type		Wetland Area	Wetland Area Intersected by the Centre Line ROW (km^2)(a)	Proportion of Wetland Area Within the LSA Intersected by the Centre Line ROW (%)(a)
Wetland Class	**Wetland Form**	**LSA (km^2)**		
Bog	Plateau	13	1	4
	Slope	43	1	3
	String	14	<1	2
	Domed	11	<1	3
	Ribbed	2	—	—
	basin	<1	—	—
	Blanket	<1	—	—
Fen	Ladder	<1	<1	<1
	Ribbed	14	<1	3
	String	<1	—	—
	Domed	<1	—	—
	Slope	19	1	4
Marsh	Riparian	1	<1	1
	Basin	<1	—	—
Peatland Complex	Domed bog-ladder fen	7	<1	1
	Domed Bog-ladder fen-slope fen	6	<1	3
	Domed bog-ribbed fen	2	—	—
	Domed bog-slope fen	5	<1	3
	Raised bog-slope fen	<1	—	—
	Ribbed fen-slope fen	22	1	3
	Domed bog-slope bog	6	<1	4
	Slope bog-ribbed fen	21	1	4
	Plateau bog-ribbed fen	3	<1	3
	Plateau bog-slope bog	2	<1	2
	Plateau bog-slope fen	1	<1	4
	Plateau Bog-string bog	1	<1	3
	String bog-ribbed fen	10	<1	1
	String bog-slope bog	7	<1	3
Total		**211**	**6**	**3**

Note: Rounding errors less than 1% may occur in the totals.
— Represents zero values.
(a) Includes 20% contingency.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The low-risk incidents (e.g., small brush fire, localized slope failure, multiple tower failure, waste spill) could result in an effect on wetlands. Considering that these events would occur within disturbed areas (e.g., ROW) and would be limited, the proposed mitigation (e.g., tower siting outside wetlands to the extent practical) will limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental release of hydrocarbons or other contaminants from spills or leaks may result in alteration or loss of wetland area during Project Construction. Accidental releases of hydrocarbons or other contaminants may occur during the fuelling or operation of vehicles or machinery, and are likely to be small (less than 30 L). The presence of released contaminants may result in vegetation and soil bacteria mortality in wetland areas. The location of the water table close to surface may facilitate the dispersion of an accidental release, and low oxygen levels (low oxidation potential) in permanently inundated soils may depress the potential decomposition of a hydrocarbon spill compared to a spill in upland (comparatively high oxidation potential) soils. The remediation of a spill would likely require the excavation and disposal of contaminated soils, resulting in a direct effect on the wetland. The proposed mitigation measures will limit the likelihood of a release of hydrocarbon or other contaminant to a wetland and the spill response plan will limit the extent of contamination.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Wetlands will likely be as follows:

- Adverse because:
  - there will likely be alteration or loss of Wetland area where, for technical reasons, complete avoidance of wetlands during site selection and routing of Project components is not possible; and
  - there will be alteration of wetlands where mitigation measures minimize, but do not completely eliminate the effects of Project Construction (e.g., minor hydrological changes adjacent to an access road or structure, accidental contaminant release or unwanted OHV traffic in wetlands).
- Of low magnitude because:
  - a maximum of 4% (1 km^2) of Wetland area in the LSA in the Avalon Peninsula region is intersected by the centre line ROW and has the potential to be affected by Project Construction;
  - a smaller proportion of Wetland a area in the LSA is crossed in the other regions (2% in Central and Southeastern Labrador, 3% on the Northern Peninsula and 3% in Central and Eastern Newfoundland); and
  - a maximum of 3% (6 km^2) of Wetland a area in the entire LSA is intersected by the centre line ROW, a conservative estimate of the amount potentially affected by Project Construction.
- Local to regional because:
  - effects are primarily confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA;
  - the direct physical disturbance to wetlands during Project Construction is primarily to the ROW; and
  - with application of appropriate mitigation measures, indirect effects could extend beyond the ROW or work areas.
- Medium to far future duration because:
  - the effect of Project Construction is medium-term duration in Wetlands where construction is undertaken in winter with the result that effects will likely be evident for between one and four years (Thibodeau and Nickerson 1986; Grigal 1985);

- the effect of Project Construction is long-term in Wetlands where construction does not occur in winter which means that effects will likely be evident for greater than 10 years (Nickerson et al. 1989); and
- the effect of Project Construction is far future in Wetlands that cannot be avoided during site selection and routing for Project components, such as roads and tower foundations.

There is a high degree of confidence that the level of effect will not be greater than predicted because the assessment is based on detailed baseline wetland mapping and the effectiveness of proposed mitigation is well documented for similar projects and wetland types. The application of the likely 20% contingency on the areas of the LSA potentially affected by the Project is expected to fully capture the effects of Project Construction on Wetlands (i.e., a precautionary approach). Further, the assessment is based on the assumption that all Wetlands crossed by the ROW will likely be affected by Project Construction. Wetlands will be avoided, where technically feasible, during ROW routing and in site selection for Project components. The amount of wetland area intersected by the centre line ROW is a conservative estimate of the amount of wetland area that has potential to be affected by the Project. Considering the avoidance and mitigation, the level of effect is likely to be less than predicted.

12.2.5.5 Construction Effects: Riparian Shoreline

The following discusses the potential effects of Project Construction on Riparian Shoreline, by region. The extent of Project interactions with Riparian Shoreline were evaluated with respect to alteration (any surface disturbance, including grading, excavation, vegetation or soil disturbance of riparian shoreline areas of watercourses and waterbodies), and considers direct and indirect effects.

The value of Riparian Shoreline in protecting and enhancing adjacent waterbodies and the habitat they support is related to the presence of a unique assemblage of vegetation, soils and hydrology that occurs at the interface between waterbodies and upland (Ilhardt et al. 2000). Alteration of vegetation and soils in Riparian Shoreline areas is likely to decrease the capacity of this area to protect and enhance adjacent waterbodies. Riparian Shoreline alteration may occur during Project Construction as a direct result of activities (e.g., clearing) required for the transmission line and electrode line ROWs, primarily. This may include removal of vegetation for transmission line installation or installation of stabilization measures (e.g., swamp mats, corduroy) at the approaches to watercourse crossings and fording sites. Accidental spills and malfunctions may also result in Riparian Shoreline alteration; the introduction of harmful substances (e.g., a fuel spill) may cause vegetation mortality and remediation of accidental spill may require direct soil and vegetation removal.

Nalcor will limit the amount of Riparian Shoreline alteration to the extent practical by routing of the ROW to avoid large waterbodies and rivers (and their associated shoreline). Where, for technical reasons, it is not possible to avoid Riparian Shoreline, site selection for the access and ROWs, appropriate mitigation as discussed previously will be employed. Within PPWSAs, appropriate riparian widths will be maintained undisturbed on waterbodies as prescribed in the Policy for Land and Water Related Developments in Protected Public Water Supply Areas (NLDEC 1999, internet site). Further to this, waterbodies within non-PPWSAs will have a minimum buffer width of 20 m. Appropriate approvals will be obtained for circumstances where, for technical reasons, this is not achievable.

The Riparian Shoreline, by region, crossed by the hypothetical 60 m wide centre line ROW (Table 12.2.5-9) informs the assessment by providing an estimate of the amount of Riparian Shoreline potentially encountered by the Project.

Table 12.2.5-9 Proportion of Riparian Shoreline Intersected by the LSA and Centre Line ROW by Shoreline Class and Region

Administrative Unit	Shoreline Class	Length of Shoreline (km)	Riparian Shoreline Intersected by the Centre Line ROW (km)[a]	Proportion of Riparian Shoreline Within the LSA Intersected by the Centre Line ROW (%)[a]
		LSA		
Central and Southeastern Labrador				
Within Protected Water Supply Area	Intake Area [b]	2	<1	9
	Waterbody [c]	1	— [e]	—
	Brook [d]	1	—	—
	Subtotal	*3*	*<1*	*<1*
Outside of Protected Water Supply Area	Major River [e]	95	3	3
	Waterbody	301	6	2
	Brook	491	18	4
	Subtotal	*886*	*27*	*3*
Total Shoreline Length in Region[f]		**886**	**27**	**3**
Northern Peninsula				
Within Protected Water Supply Area[g]	Major River	8	1	7
	Waterbody	60	5	9
	Brook	35	4	11
	Subtotal	*104*	*10*	*10*
Outside of Protected Water Supply Area	Major River	45	3	8
	Waterbody	651	30	5
	Brook	279	22	8
	Subtotal	*975*	*56*	*6*
	Scheduled Salmon river[h]	19	1	7
Total Shoreline Length in Region[f]		**1,079**	**66**	**6**
Central and Eastern Newfoundland				
Within Protected Water Supply Area	Major River	78	3	4
	Waterbody	66	3	5
	Brook	134	10	7
	Subtotal	*279*	*16*	*6*
	Scheduled Salmon River	36	2	6
Outside of Protected Water Supply Area	Major River	107	7	7
	Waterbody	290	18	6
	Brook	374	27	7
	Subtotal	*771*	*53*	*7*
	Scheduled Salmon River	34	2	5

Table 12.2.5-9 Proportion of Riparian Shoreline Intersected by the LSA and Centre Line ROW by Shoreline Class and Region (continued)

Administrative Unit	Shoreline Class	Length of Shoreline (km)	Riparian Shoreline Intersected by the Centre Line ROW (km)[(a)]	Proportion of Riparian Shoreline Within the LSA Intersected by the Centre Line ROW (%)[(a)]
		LSA		
Total Shoreline Length in Region[(a)]		**1,049**	**69**	**7**
Avalon Peninsula				
Within Protected Water Supply Area	Intake	0.1	—	—
	Waterbody	73	4	5
	Brook	16	1	5
	Subtotal	*89*	*5*	*5*
Outside of Protected Water Supply Area	Waterbody	372	21	6
	Brook	177	14	8
	Subtotal	*549*	*35*	*6*
	Scheduled Salmon River	12	<1	3
Total Shoreline Length in Region[(f)]		**638**	**39**	**6**
Total Shoreline Length in all Regions		**3,769**	**229**	**6**

Note: Rounding errors less than 1% may occur in the totals.

— Represents zero values.

(a) Includes 20% contingency.

(b) Intake Area: A pond, lake or river from which drinking water is extracted or withdrawn for public use. An intake pond or lake requires proponents to provide a minimum of 150 m width buffer zone, from the high water mark, along and around waterbodies in a designated area. In the case of river intake areas, a minimum of 150 m for a distance of one km upstream and 100 m downstream of the affected area is required for a buffer.

(c) Waterbody: A waterbody identified in the provincial hydrology mapping (NRCan 2010, internet site) as a waterbody-freshwater and includes lakes and ponds (but not wetlands). Waterbodies are mapped as shape features. In a PPWSA proponents are required to provide a minimum of 50 m width buffer zone, from the high water mark of a waterbody.

(d) Brook: A watercourse identified in the provincial hydrology mapping (NRCan 2010, internet site) as a waterbody-brook. Brooks are mapped as line features. Minor tributaries and non-major rivers. In a PPWSA proponents are required to provide a minimum of 30 m width buffer zone, from the high water mark from a brook. In a non-PPWSA, a minimum buffer width of 20 m is established.

(e) Major River: A watercourse identified in the provincial hydrology mapping (NRCan 2010, internet site) as a waterbody-river. Major rivers are mapped as shape features (left and right bank). Proponents are required to provide a minimum of 75 m width buffer zone, from the high water mark, along and around rivers in a PPWSA.

(f) Calculated from provincial hydrology mapping (NRCan 2010, internet site), PPWSA mapping (NLDEC 2010a, internet site) and scheduled salmon river mapping (DFO 2009, internet site).

(g) PPWSA are designated and regulated by the NLDEC under the *Water Resources Act* (2002). Section 39 of the *Water Resources Act* prohibits all activities in PPWSAs which have potential to impair water quality. No development activity are permitted in specified buffer zones except those which are intended to promote vegetation.

(h) Scheduled Salmon River: Includes the main stem of a river including tidal waters at the mouth of a river inside DFO bait and spinner signs; the waters of any connected pond or lake within 90 m of the river's entrance and outlet, or as indicated by DFO signs; in many cases, tributary streams; in a few cases, certain lakes and ponds. There are 186 scheduled salmon rivers in Newfoundland and Labrador (DFO 2009, internet site).

Approximately 6% (229 km) of total Riparian Shoreline within the LSA is intersected by the centre line ROW, representing the estimated amount of Riparian Shoreline that has the potential to be affected by Project Construction (Table 12.2.5-9). The proportion of Riparian Shoreline intersected by the centre line ROW is consistent between the regions (6% to 7%). This is a conservative estimate because the appropriate mitigation, including buffers will be implemented. Therefore, the amount of Riparian Shoreline potentially disturbed during the Project is likely to be less than 6%.

PPWSAs are present in all regions of the LSA. Riparian Shoreline within PPWSAs is protected by the NLDEC under the *Water Resources Act* (2002) as noted earlier in the mitigation proposed for the Project. Buffer zones are specified for the different shoreline classes identified in Table 12.2.5-9 in which no development activity is permitted except those that are intended to promote vegetation growth. The proportion of regulated Riparian Shoreline intersected by the centre line ROW varies by region. The largest proportion of PPWSA Riparian Shoreline is intersected in the Northern Peninsula (10% or 10 km) and the smallest proportion (<1% or 1 km) is intersected in Central and Southeastern Labrador. The largest total amount of PPWSA Riparian Shoreline (16 km or 6%) is intersected in Central and Eastern Newfoundland. These areas will be a priority for avoidance and / or mitigation during final ROW route selection and site selection for Project components.

Scheduled salmon river shoreline is intersected in each region of the LSA except for Central and Southeastern Labrador (Table 12.2.5-9). There is no scheduled salmon river shoreline crossed by the LSA in the Central and Southeastern Labrador region.

A total of 101 km of scheduled salmon river shoreline is present in the LSA, 5 km (5%) of which is intersected by the centre line ROW. The amount intersected by the centre line ROW ranges from 1 km (7%) in the Northern Peninsula to 4 km (6%) in Central and Eastern Newfoundland. The Central and Eastern Newfoundland region has the most scheduled salmon river shoreline (4 km, or 5%) in the LSA. In the Northern Peninsula region, a larger proportion of the scheduled salmon river shoreline within the LSA is affected (7%); however, this only represents a potential effect of 1 km of shoreline. Three percent of the 12 km of scheduled salmon river shoreline that occurs within the LSA on the Avalon Peninsula has the potential to be affected by the Project. This shoreline class will be a priority for avoidance and / or mitigation during final ROW route selection and site selection for Project components.

There is potential for the establishment of non-native and invasive species in riparian shoreline as a result of ROW construction. Seeds and propagules may be transported on construction vehicles, and disturbance of adjacent areas creates changes in the local conditions (e.g. light availability) that facilitate the establishment of new plants. The proposed mitigation measures (e.g., inspection of equipment before use and vegetation stabilization) will limit the potential for the introduction and establishment of non-native and invasive species in riparian shoreline areas. Due to the remote nature of the majority of the LSA, the local abundance of seeds and propagules for introduction to riparian areas affected by the Project is likely to be low.

The construction of the ROW and Project components may allow accessibly of Riparian Shoreline intersected by and adjacent to the ROW to OHV traffic. The presence of construction crews and equipment is likely to deter this type of unwanted traffic during Construction.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The low-risk incidents (e.g., small brush fire, localized slope failure, multiple tower failure, waste spill) could result in an effect on riparian shoreline. Considering that these events would occur within disturbed areas (e.g., ROW) and would be limited, the proposed mitigation (e.g., adherence to buffer width) will limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental release of hydrocarbons or other contaminants from spills or leaks may result in alteration of riparian during Project Construction. Accidental releases of hydrocarbons or other contaminants may occur during the fuelling or operation of vehicles or machinery, and are likely to be small (less than 30 L). The presence of contaminants may result in vegetation and soil bacteria mortality in riparian shoreline areas. The remediation of a spill would likely require the excavation and disposal of contaminated soils, resulting in a direct loss of riparian shoreline. The proposed mitigation measures will limit the likelihood of a release of hydrocarbon or other contaminant to a riparian area (e.g., fuelling of vehicles and storage of fuel a minimum of 30 m from a wetland).

The Project effects on Riparian Shoreline are expected to occur primarily to treed vegetation. This means that the majority of the functions of riparian areas related to bank stability, erosion control, and water filtration will continue to occur within areas affected by the Project.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Riparian Shoreline are as follows:

- Adverse because:
  - there will be alteration of Riparian Shoreline (i.e., vegetation removal and installation of mitigation measures, such as swamp mats) in areas where, for technical reasons Riparian Shoreline cannot be avoided during the route selection for Project components (e.g., at a necessary fording site or where an access road crosses a watercourse);and
  - there may be alteration of Riparian Shoreline as a result of the introduction of non-native or invasive species, or the presence of unwanted OHV traffic as a result of Project Construction.
- Of low magnitude because:
  - Of the total amount of Riparian Shoreline in the LSA, 6% (229 km) is potentially intersected by the Project, representing a conservative estimate. The majority of this habitat will remain undisturbed through avoidance to the extent practical during final ROW route selection and site selection for Project features such as roads and tower foundations. The amount altered will be minimized through appropriate mitigation (e.g., minimal disturbance to vegetation, as feasible, and the establishment of buffer areas).
- Local to regional because:
  - effects are primarily confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA;
  - direct alteration of Riparian Shoreline is expected to primarily occur within the transmission line ROWs in each region; and
  - indirect alteration, extending beyond the ROW, will be minimized by appropriate mitigation.
- Of medium to far future duration because:
  - the effect of Project Construction on riparian shoreline will occur over the four year construction period;
  - the effect of Project Construction is medium-term duration in areas of Riparian Shoreline where vegetation is cleared and allowed to regenerate; and
  - the effect of Project Construction is far future in areas of Riparian Shoreline that, for technical reasons, cannot be avoided in site selection for Project components, such as access roads.

There is a high degree of confidence that the level of effect will not be greater than predicted because the mapping of Riparian Shoreline is based on the best available mapping of watercourses and waterbodies in Newfoundland and Labrador (NRCan 2010, internet site) and criteria for potential Project effects are conservative. The centre line ROW used to inform the assessment does not consider avoidance and disturbance within affected areas will comply with regulations and buffers to minimize disturbance. Further, the application of the 20% contingency on the areas of the LSA potentially affected by the Project is a conservative estimate of the effects of Project Construction on Riparian Shoreline (i.e., a precautionary approach).

12.2.5.6 Construction Effects: Listed Plants

Direct (e.g., vegetation disturbance and / or removal) and indirect (e.g., non-native and invasive species, pathogens) alteration or loss are the most important factors affecting Listed Plants during Construction. Construction activities have the potential to affect known individual Listed Plants and / or plant populations, with additional effects to those habitats that support Listed Plants within the LSA. As well, site preparation activities could result in changes to environmental conditions within and adjacent to the ROW and other Project components, with potential changes to known occurrence of Listed Plants and / or their habitats.

Habitat will be altered or lost due to vegetation clearing, grubbing and stripping of overstorey and ground vegetation from within the ROW and other Project components. The removal of key habitat characteristics (e.g., adjacent forest cover) along the ROW may lead to higher ground temperatures and localized changes in groundwater or surface water movement and Angold (1997) indicated that such effects may extend as far as 200 m from clearing or access road edges. As such, these activities may adversely affect the microhabitats necessary to support Listed Plants or plant populations. Indirectly, even if the adjacent vegetation and / or soils are not affected by Construction activities, changes in growing conditions, such as level of light exposure, soil temperature or soil moisture regime, may affect the viability of plants in proximity to cleared areas.

Other indirect adverse effects are possible as a result of increased access to previously remote areas. This could result in the introduction of non-native and invasive weeds species through vehicle traffic, or increased travel through and resulting damage by OHVs to habitats supporting Listed Plants.

As identified above, there is also potential for accidental releases of hydrocarbons or other hazardous materials within work areas. The degree of effect or consequence associated with such an event, and resultant adverse effect on Listed Plants would be largely dependent on the nature and extent (i.e., type of material and the volume released) of the disturbance, as well as the time of year.

The presence of Listed Plant species, including consideration of lichens, or their important habitats within the LSA was established based on information provided by the ACCDC (2010, internet site). To assess the potential effects of the Project on Listed Plants, the known occurrence(s) of all *SARA* and *NLESA*-listed plant species were obtained, reviewed and compared with the spatial boundaries of the LSA. Based on existing available information (ACCDC 2010, internet site; *SARA* Public Registry (Environment Canada 2010b, internet site)), known occurrences of as many as four Listed Plant species including, three vascular plant species (i.e., Long's braya, Fernald's braya, Fernald's milk-vetch) and one lichen, the boreal felt lichen (Table 12.2.5-10) were identified within the LSA. Detailed descriptions and the current known distribution and / or occurrence of these species are provided in Chapter 10 (Section 10.3.3; Figure 10.3.3-12; Figure 10.3.3-13; Figure 10.3.3-14; and Figure 10.3.3-15). Additional occurrences of these species (i.e., other than those previously documented) are possible within preferred habitat occurring within the LSA.

Construction of Project components in Labrador may have a limited effect on Listed Plants. Similarly, construction of submarine cable landing sites and the shoreline electrode site at L'Anse au Diable may have minor associated effects on Listed Plants and / or their habitats at these locations in Labrador. The electrode site in Labrador will involve limited disturbance, as it has been sited within areas of existing disturbance; the shoreline electrode site at Dowden's Point is outside the known distribution of listed plants and will not have any interaction. Construction activities will likely have a limited effect on the availability of suitable habitat at the local level, and no effect on Listed Plant populations at the regional level.

Table 12.2.5-10 Listed Plants Occurring within the LSA

Species	Occurrence in LSA
Central and Southeastern Labrador	
Long's braya[(a)]	No recorded occurrence(s)
Fernald's braya[(a)]	No recorded occurrence(s)
Fernald's milk-vetch	Endemic to Strait of Belle Isle region. Identified within the LSA at Forteau Bay, in proximity to the proposed submarine cable landing site.
Boreal felt lichen	No recorded occurrence(s)
Northern Peninsula	
Long's braya[(a)]	Endemic to Northern Peninsula region. Within the LSA, it is restricted to the limestone barrens, in particular within a few small areas near Shoal Cove.
Fernald's braya[(a)]	Endemic to Northern Peninsula region. Within the LSA, it is restricted to the limestone barrens, in particular within a few small areas around Shoal Cove and Green Island Brook.
Fernald's milk-vetch	Endemic to Strait of Belle Isle region. No recorded occurrence(s).
Boreal felt lichen	No recorded occurrence(s)
Central and Eastern Newfoundland	
Long's braya[(a)]	No recorded occurrence(s)
Fernald's braya[(a)]	No recorded occurrence(s)
Fernald's milk-vetch	No recorded occurrence(s)
Boreal felt lichen	No recorded occurrence(s)
Avalon Peninsula	
Long's braya[(a)]	No recorded occurrence(s)
Fernald's braya[(a)]	No recorded occurrence(s)
Fernald's milk-vetch	No recorded occurrence(s)
Boreal felt lichen	Potentially within the LSA where it crosses the Avalon Forest Ecoregion, most notably in the area of Hall's Gullies and Lockyer's Waters on the Avalon Peninsula.

(a) Endemic to the unique, coastal limestone barren ecosystems of the Northern Peninsula, covering an area of approximately 150 km spanning a north-south axis from Point Riche in the South to Burnt Cape in the North.

Nalcor will avoid known occurrences of Listed Plants and / or important habitat during the final routing and siting of the Project ROW and associated Project components, where possible. As shown in Table 12.2.5-10, this will be of particular concern in Central and Southeastern Labrador, particularly near Forteau Point, and at Shoal Cove on the Northern Peninsula. When routing or siting of Project components cannot avoid these areas, Nalcor will conduct pre-Construction floristic surveys of important habitat for Listed Plants with potential to be affected by the final Project component location or alignment. Should any individual Listed Plant species be located, Nalcor will retain a qualified botanist to assist in the development and implementation of an appropriate mitigation strategy, in consultation with the appropriate regulatory agencies, as discussed above. The determination of effective mitigation will depend on site-specific conditions such as terrain, available work space and access, as well as that of species sensitivity characteristics, including regulatory (*SARA* and *NLESA*) status, abundance and potential for transplanting or propagation success.

Listed Plant species could decline in cleared areas, particularly where a species habitat affinity is affected by changes in the availability or physical characteristics (i.e., structural stage) of those habitats (e.g., reliance of boreal felt lichen on specific components of the mature to over-mature Coniferous Forest Habitat Type)

(Keeping and Hanel 2006). Given that the listed braya species identified have an affinity for the calcareous substrates and nutrient-poor conditions typical of the limestone barrens ecosystems of the Northern Peninsula, potential effects on this species will be mitigated through avoidance or by scheduling Construction activities outside the normal growing season and during periods of increased snow cover, as practical.

There is potential for the establishment of non-native and invasive species in all habitats, including those occupied by Listed Plants as a result of Project Construction. Seeds and propagules may be transported on construction vehicles, and disturbance of adjacent areas creates changes in the local environmental conditions (e.g., light availability, temperature, air flow,) that facilitate the establishment of new plants, with potential for the competitive exclusion of listed plants from their preferred habitats. The proposed mitigation measures above (e.g., inspection of equipment before use and vegetation stabilization) will limit the potential for the introduction and establishment of non-native and invasive species in previously undisturbed areas. Natural mitigating factors in Labrador, including cold temperatures, short growing seasons, nutrient poor substrates and arid conditions will reduce numbers of non-native and invasive species that establish and rates of spread. Due to the remote nature and location of the majority of the LSA, the local abundance of non-native and invasive seeds and propagules for introduction to those areas affected by the Project is low.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The low-risk incidents (e.g., small brush fire, localized slope failure, multiple tower failure, release of drilling mud, waste spill) could result in an effect on Listed Plants. Considering that these events would occur within disturbed areas (e.g., ROW) and would affect a limited area, the proposed mitigation will limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental release of hydrocarbons or other contaminants from spills or leaks may result in alteration or loss of Listed Plants during Project Construction. Accidental releases of hydrocarbons or other contaminants may occur during the fuelling or operating of vehicles or machinery, and are likely to be small (less than 30 L). The presence of contaminants may result in vegetation and soil bacteria mortality where they occur in native habitats. The remediation of a spill would likely require the excavation and disposal of contaminated soils, resulting in a direct loss of vegetation. Where these incidents occur in proximity to a known Listed Plant occurrence or their important habitats potential adverse effects may result, but are not expected. The mitigation measures proposed by Nalcor will limit the likelihood of a release of hydrocarbon or other contaminant into the natural environment. Where avoidance of listed plants is not possible, Nalcor, in consultation with federal and provincial regulators, will develop protection measures and environmental management techniques for listed plant species based on site-specific conditions and species sensitivity criteria.

Summary of Likely Residual Environmental Effects

Given Nalcor's commitment to avoidance of Listed Plant species and associated important habitats, where possible, the likely residual effects of Project Construction on Listed Plants are as follows:

- Adverse because:
  - Construction activities, in particular those associated with the cable landing sites and the trenches required to connect to the transition compound at the Strait of Belle Isle, near Forteau Point in Central and Southeastern Labrador and at Shoal Cove on the Northern Peninsula, will affect important habitat known to support Listed Plant species within the LSA;
  - there is potential for effects on individuals Listed Plants or alteration to their important habitats as a result of clearing, fragmentation of habitat, non-native and invasive plant species, accidental spills of hydrocarbons and other hazardous materials and / or potential for increased OHV access / traffic along the ROW; and
  - by their nature, Listed Plant species and / or their preferred habitats are particularly sensitive to any form of disturbance.

- Of low magnitude because:
  - the effects of the Project are likely to result in the alteration of <5% of known Listed Plant species individuals or locations;
  - known locations of individual Listed Plants or plant populations will be avoided, to the extent practical. Where avoidance is not possible, approved mitigation techniques will be implemented to minimize adverse effects; and
  - the likelihood of accidents, spills, or malfunctions during Construction is low and following the proposed mitigation measures and EPP for the Project will mitigate potential environmental effects of accidental events.
- Local to regional because:
  - effects on the individuals or locations of listed species will be primarily confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.
- Of far future duration because:
  - any unavoidable alteration or loss of Listed Plants or their preferred habitat will persist beyond Construction, throughout the life of the Project; and
  - slow growing conditions, including cold, nutrient-poor substrates and generally thin soils associated with some geographic regions (e.g., Central and Southeastern Labrador and portions of the Northern Peninsula) or Habitat Types will limit regeneration potential.

The frequency of the effect of Project Construction on Listed Plants will range from infrequent (e.g., ROW clearing) to frequent (e.g., OHV access). There is a high degree of confidence that the level of effect will not be greater than predicted because direct environmental effects from the Project were quantified. In July 2011, Nalcor conducted a plant survey of both cable landing sites, and the electrode sites for listed plants. In addition, Nalcor also used existing spatial information (i.e., *SARA* Public Registry (Environment Canada 2010b, internet site); ACCDC 2010, internet site) for known occurrences of Listed Plant species as supplementary information. Information and insight gained through this process was further substantiated through queries of the ACCDC database records previously conducted in 2008 (Stantec 2010a) and again in 2010. Nalcor's commitment to pre-construction field surveys contributes to an increase in the overall level of certainty regarding the interaction of the Project and listed plant species occurring within the LSA. Furthermore, the use of an adaptive management approach during construction will allow any issues to be identified and addressed in a proactive manner.

12.2.5.7 Construction Effects: Regionally Uncommon Plants

As for vegetation abundance and diversity, the degradation and alteration or loss of habitat (i.e., Habitat Types) has the greatest potential to affect Regionally Uncommon Plants. Changes in the preferred habitats for the identified Regionally Uncommon Plant species relevant to the Project will occur due to vegetation clearing, with important habitats likely altered or lost, due to Construction activity, erosion, emissions and dust. Clearing of overstorey and ground vegetation, in association with stripping / grubbing / grading at specified locations within the ROW and other Project components will result in the majority of the vegetation alteration or loss associated with the Project. Indirectly, the resulting environmental changes along the ROW due to removal of key habitat characteristics (e.g., adjacent forest cover) may include higher ground temperatures and localized changes in groundwater or surface water movement. These activities may adversely affect the microhabitats necessary to support Regionally Uncommon Plants or plant populations.

The introduction of non-native and invasive weeds species through vehicle traffic could potentially affect regionally uncommon plant species or their preferred habitats within the LSA. Access will be required along the entire ROW, on access trails and roads, intermittently throughout the four year construction period. Traffic associated with Project Construction, while intermittent, still presents the potential for direct disturbance and airborne dust generation and particulate emissions, with possible adverse affects on ground vegetation, particularly during the drier summer months. There is also potential for accidental releases of hydrocarbons or other hazardous materials. The effect of such an event on regionally uncommon plant potential habitat would be largely dependent on the nature and extent (i.e., type of material and the volume released) of the disturbance.

To assess potential Project effects, regionally uncommon plant species (i.e., those ranked SH, S1 or S2 by ACCDC) with potential to occur within the LSA were obtained, reviewed and compared with the spatial boundaries of the LSA. The presence of regionally uncommon plants (including lichens) within the RSA, LSA, and the hypothetical 60 m wide centre line ROW, was established on the basis of existing, recent information provided by the ACCDC (ACCDC 2010; Hanel 2011, pers. comm.) and other scientific authorities (Meades 2011 pers. comm.). Based on this information, a potential list of 15 Regionally Uncommon Plant species was identified for Central and Southeastern Labrador, with 122 occurrences noted within habitats potentially affected by the Project in Newfoundland. For a compiled list of Regionally Uncommon Plant species, their habitat requirements, and their distribution within the RSA and LSA, refer to Section 10.3.3 in Chapter 10.

Recognizing the size, scale and geographic distribution of the Project and as described above in Analytical Methods, a regional-scale habitat model was used to predict, based on coarse-scale GIS data (ACCDC 2010, internet site), the spatial distribution of areas containing potential habitat for Regionally Uncommon Plant species and the probability of encountering potential Regionally Uncommon Plants.

Habitat modelling (Stantec 2010a) demonstrated that areas comprising approximately 5% of the RSA in Central and Southeastern Labrador and approximately 5% of the LSA were classed as having High or Very High potential to support Regionally Uncommon Plants (Table 12.2.5-11). In Newfoundland, High or Very High potential was assigned to polygons comprising a total of 14% and 13% of the RSA and LSA, respectively. High and Very High quality habitat was found throughout much of the LSA, with the Northern Peninsula region containing the highest diversity and distribution of Regionally Uncommon Plant species. The Northern Peninsula has the largest overall proportion of suitable habitat (rated High or Very High) for these species, with 175 km^2 or 36% of the LSA within the region appropriately characterized, including 3 km^2 (20%) of High and 3 km^2 (15%) of Very High potential habitat crossed by the centre line ROW. By contrast, the Avalon Peninsula has no suitably rated habitat crossed by the centre line ROW (Table 12.2.5-11). All other Habitat Types were rated as low and moderate.

Overall, the area of Regionally Uncommon Plant potential habitat rated High or Very High within the LSA, and that could be affected as a result of the Project, is low (3%) (Table 12.2.5-11). Based on the centre line ROW estimate, the Project could intersect 5 km^2 of High and 4 km^2 of Very High potential habitat that is available in the LSA (Table 12.2.5-11). In total, as estimated by the use of the centre line ROW has the potential to affect approximately 11% of potential habitat rated High or Very High, this represents approximately 8% of the habitat rated High or Very High for Regionally Uncommon Plant potential within the LSA.

There is potential for the establishment of non-native and invasive species in all habitats, including those occupied by Regionally Uncommon Plants, as a result of Project Construction. Seeds and propagules may be transported on construction vehicles, and disturbance of adjacent areas creates changes in the local environmental conditions (e.g. light availability, temperature, air flow) that facilitate the establishment of new plants, with potential for the competitive exclusion of regionally uncommon plants from their preferred habitats. The proposed mitigation measures (e.g., inspection of equipment before use and vegetation stabilization) will limit the potential for the introduction and establishment of non-native and invasive species in previously undisturbed areas. Due to the remote nature of the majority of the LSA, the local abundance of non-native and invasive seeds and propagules for introduction to those areas affected by the Project is low.

Table 12.2.5-11 Habitat Potential for Regionally Uncommon Plants Intersected by the LSA and the Centre Line ROW, by Region

Habitat Potential for Regionally Uncommon Plant	LSA		Centre Line ROW		% of Available Habitat within the LSA Potentially Affected
	Total Area (km^2) of LSA	% of LSA	Total Area (km^2) of Centre Line ROW	% of ROW	
Central and Southeastern Labrador					
High	10	1	<1	1	3
Very High	31	4	1	4	3
Subtotal	*41*	*5*	*<2*	*5*	*6*
Total Available Habitat[(a)]	**770**	—	**28**	—	—
Northern Peninsula					
High	105	22	4	22	4
Very High	70	14	3	17	4
Subtotal	*175*	*36*	*7*	*35*	*8*
Total Available Habitat[(a)]	**485**	—	**18**	—	—
Central and Eastern Newfoundland					
High	5	<1	<1	<1	0
Very High	5	<1	<1	<1	0
Subtotal	*10*	*1*	*<1*	*<1*	*0*
Total Available Habitat[(a)]	**654**	—	**24**	—	—
Avalon Peninsula					
High	<1	<1	0	0	0
Very High	0	0	0	0	0
Subtotal	*<1*	*<1*	*0*	*0*	*0*
Total Available Habitat [(a)]	**248**	—	**9**	—	—
Newfoundland (Total)					
High	110	8	4	8	4
Very High	75	5	3	6	4
Subtotal	*185*	*13*	*7*	*14*	*8*
Total Available Habitat [(a)]	**1,386**	—	**50**	—	—
Newfoundland and Labrador (Subtotal)					
High	120	6	5	6	4
Very High	106	5	4	5	4
Subtotal	*226*	*10*	*9*	*11*	*8*
Total Available Habitat [(a)]	**2,156**	—	**77**	—	—

Note: Rounding errors less than 1% may occur in the totals. Centre line ROW calculations include the 20% contingency.
— Represents null values.
[(a)] Total of all low, moderate, high and very high habitat available.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The low-risk incidents (e.g., small brush fire, localized slope failure, multiple tower failure, release of drilling mud, waste spill) could result in an effect on Regionally Uncommon Plants. Considering that these events would occur within disturbed areas (e.g., ROW) and would affect a limited area, the proposed mitigation will limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental release of hydrocarbons or other contaminants from spills or leaks may result in alteration or loss of Habitat Types rated High and Very High for Regionally Uncommon Plant potential during Project Construction. Accidental releases of hydrocarbons or other contaminants may occur during the fuelling and operation of vehicles or machinery, and are likely to be small (less than 30 L). The presence of contaminant may result in vegetation and soil bacteria mortality where they occur in native habitats. The remediation of a spill would likely require the excavation and disposal of contaminated soils, resulting in a direct loss of vegetation. Where these incidents occur in proximity to those habitats rated High or Very High for regionally uncommon plant potential adverse effects may result. The proposed mitigation measures will limit the likelihood of a release of hydrocarbon or other contaminant into the natural environment. Where avoidance of regionally uncommon plants is not possible, Nalcor, in consultation with federal and provincial regulators, will develop protection measures and environmental management techniques for Regionally Uncommon Plant species based on site-specific conditions and species sensitivity criteria.

Similarly, and in conjunction with mitigation measures specified above for Listed Plants, adverse effects to Regionally Uncommon Plant species within the ROW will be mitigated using pre-construction botanical surveys of suitably rated (High or Very High) habitats that are affected by the final Project components and alignment. Following implementation of recommended mitigation measures, with preference for avoidance wherever feasible, Project-related environmental effects on regionally Uncommon Plant species will be minimal.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Regionally Uncommon Plant species are as follows:

- Adverse because:
  - even after avoidance, a decrease in the area of Habitat Types (rated High or Very High) that support Regionally Uncommon Plant species is likely; and
  - alteration or loss resulting from clearing (fragmentation of habitat) will likely facilitate the establishment and spread of non-native and invasive species invasive species and increased OHV access / traffic along the ROW, trails and access roads.
- Of low magnitude because:
  - effects are predicted on <1% of habitat rated High or Very High for regionally Uncommon Plant species across all four regions; and
  - the likelihood of accidents, spills, or malfunctions during Construction is low and the proposed mitigation measures and EPP for the Project will mitigate environmental effects of accidental events.
- Local to regional because:
  - physical disturbance to Regionally Uncommon Plant habitats will primarily be limited to the LSA, but some effects (e.g., dust) could extend slightly into the RSA;
- Of far future duration because:
  - any unavoidable loss or alteration Regionally Uncommon Plants will be evident beyond Construction, and persist throughout the life of the Project; and

- slow growing conditions, including cold, nutrient-poor substrates and generally thin soils associated with some geographic regions (e.g., Central and Southeastern Labrador and portions of the Northern Peninsula) or Habitat Types will limit regeneration potential.

The effect of Project Construction Regionally Uncommon Plants is constant over the four-year Construction period and will be measurable for the life of the Project.

There is a moderate degree of confidence that the level of effect will not be greater than predicted. Direct effects from the Project were evaluated at two levels. First, existing spatial information on the known occurrences of Regionally Uncommon Plant species, as provided by ACCDC, was used to support the Regionally Uncommon Plant potential model (Stantec 2010a). In some cases, rankings of Labrador plant species are based on a conservative ranking approach due to the limited knowledge of plant species distribution. Secondly, baseline vegetation mapping of the LSA used to support the Regionally Uncommon Plant potential model is considered accurate and will be used in conjunction with pre-Construction botanical surveys to minimize potential Project effects on Regionally Uncommon Plant species. The coarse-scale of available mapping (Stantec 2010b) does not permit the differentiation of fine-scale vegetation communities and is therefore of limited value as predictors of habitat potential. A small number of Regionally Uncommon Plant species possess niche habitat requirements that exist within, and are typically different from areas of the more general Habitat Types. Additionally, the ability to successfully re-establish Regionally Uncommon Plants is unproven for the majority of species. The application of the 20% contingency on the areas of the LSA potentially affected by the Project fully captures the effects of Project Construction on Regionally Uncommon Plant species (i.e., a precautionary approach). Further, Nalcor's commitment to consult with NLDEC Wildlife Division once the ROW has been selected to allow for a more precise identification of areas with high potential habitat for regionally uncommon plants also adds the confidence of the predicted effect.

Nalcor has also committed to re-run the Regionally Uncommon Plant model once a ROW has been selected, based on input and advice from the NLDEC Wildlife Division.

12.2.5.8 Construction Effects: Timber Resources

Alteration or loss of the productive forested landbase (i.e., Conifer Forest, Hardwood Forest, Mixedwood Forest Habitat Types) will have the most relevant effect of Project Construction on Timber Resources. Changes in the abundance and diversity of vegetation will occur due to vegetation clearing, with Habitat Types altered or lost, due to disturbance from human activity, erosion, emissions and dust. Clearing of the ROW will account for the majority of the vegetation alteration or loss associated with the Project, removing all trees and a substantial amount of lower-growing vegetation exceeding 2 m in height from the ROW. Additionally, there will be alteration or loss of vegetation associated with access roads, tower foundations and other Project infrastructure, where areas will be cleared of vegetation, stripped of topsoil and graded to expose bare earth. These areas will remain in an un-vegetated and / or unnatural state for the life of the Project, thus leading to shifts in the available productive forest landbase within the relevant Project components (i.e., those constructed within a forest). While the majority of clearing will occur within the ROW, a minimal amount of disturbance to standing trees outside the designated work areas will likely during preparation of the ROW, through timber harvesting operations and access road construction. Through these activities, topsoil is often disturbed, compacted, or removed. Although not always immediately apparent, damage to tree roots, with potential effects on overall tree health, can also occur.

Where they intersect with late-successional forest habitats, transmission line ROWs, access roads and trails, contribute to the size and extent of forest openings on the landscape, increasing edge to interior conditions of forest openings and mature forest, increasing the area of "edge" habitats and thus introducing edge effects. Edge effect is generally considered to be the influence exerted on a stand or forest opening as compared to the interior of the stand or forest. The effect of forest openings on adjacent "edge-influenced" habitats varies. Studies have shown that there can be more vegetative cover along roadsides and ROWs than in adjacent habitats. These increases in species richness (diversity) along roadsides have, however, largely been attributed to increases in non-native and invasive weed species dispersal along access roads and trails (Holzapfel and Schmidt 1990).

Movement and presence of personnel, equipment and materials during Construction will result in disturbance and alteration or loss of vegetation from the immediate area. Transmission tower assembly and tower and conductor installation will present localized disturbance, however, the transporting of materials on-site will be disruptive over a larger area, as vehicle traffic (e.g., heavy machinery, tracked vehicles) may be used to convey larger components to and from the site. As a result of such movements, the transmission corridor and access roads could become vectors for the distribution of non-native and invasive species into the LSA. These species could affect native plant species and / or plant populations through competitive exclusion, outcompeting natural vegetation for resources (e.g., available nutrients) and, where conditions permit, alter ecosystem function. Disturbed areas and habitat edges, such as transmission line ROWs, access trails and roads, are particularly prone to invasions of non-native species that once established often continue to spread to adjacent habitats causing adverse effects on vegetation abundance and diversity and resultant changes in ecosystem function. The unintended introduction of forest pests (e.g., spruce budworm) and plant pathogens, via dispersal along the transmission corridor and access, can also affect forest ecology with adverse effects on local Timber Resources.

Indirect effects to Timber Resources may result due to increased access to previously remote areas. Timber Resources are present within mid- and late-successional forest habitats intersected by the Project and the corridor will provide improved access to these areas. As such, Timber Resources could be affected by the domestic cutting of timber for fuel wood and saw logs along the ROW and access roads. It is unlikely that access to previously inaccessible forest habitats would result in excessive timber clearing or loss of merchantable timber, particularly in Labrador, where the productive forest landbase is limited by the widespread location. The effect would be most important in Newfoundland where most of the suitable forest habitat has been allocated to the forest sector, the forest landbase is highly fragmented and a substantial portion of the population base resides.

Based on the centre line ROW (which includes 20% contingency) estimate, the Project will affect approximately 24 km^2 (3%) of the 735 km^2 of available productive forest landbase (i.e., merchantable timber) within the LSA (Stantec 2011b). Due to operational and safety considerations, this is landbase that will not be allowed to regenerate to a productive forest state over the course of the Project. GMV was also calculated for all trees with an outside bark diameter of 9.0 cm or greater at a point 1.3 m above mean ground level (i.e., diameter at breast height). Table 12.2.5-12 summarizes timber resources within the LSA and centre line ROW for each region in Newfoundland and Labrador.

Table 12.2.5-12 Gross Merchantable Volume (Softwood / Hardwood) within the LSA and Centre Line ROW, by Region

Region	Gross Merchantable Timber Volume					
	LSA			Centre Line ROW		
	GMV - Softwood (m^3)	GMV - Hardwood (m^3)	Total GMV (m^3)	GMV - Softwood (m^3)	GMV - Hardwood (m^3)	Total GMV (m^3)
Central and Southeastern Labrador[(a)]	706,207	0	706,207	25,991	0	25,991
Northern Peninsula	1,543,124	146,087	1,689,210	59,695	5,555	65,250
Central and Eastern Newfoundland	1,723,594	186,514	1,910,108	65,144	6,557	71,701
Avalon Peninsula	256,609	16,197	272,806	8,022	468	8,490
Total	**4,229,534**	**348,798**	**4,578,331**	**158,852**	**12,580**	**171,432**

Note: Rounding errors less than 1% may occur in the totals. Centre line ROW calculations include the 20% contingency.
[(a)] The GMV calculations for Labrador are for softwoods only and were calculated using NLDNR yield-based methodology, as stand and stock table data are not presently available.

For Newfoundland, the GMV of productive forest (softwood / hardwood) within the LSA and centre line ROW is 3,872,124 m^3 and 145,441 m^3, respectively (Table 12.2.5-12). In Labrador, the GMV of productive forest was calculated for softwoods only, with the available timber volumes in the LSA and ROW estimated at 706,207 m^3 and 25,991 m^3, respectively. Total volumes (Newfoundland and Labrador) of the Timber Resources were estimated at 4,229,534 m^3 for the LSA and 171,432 m^3 for the centre line ROW, respectively.

The majority of effects to Timber Resources will occur during the Construction phase of the Project. The Project will result in a loss of timber production, removing this area from the productive forest landbase. Merchantable cleared will be salvaged in accordance with provincial guidelines. Where practical and feasible, timber harvested, but not intended for commercial use, will be stacked to the side of the ROW where it will be available for domestic use. At the end of the Construction phase, the ROWs will remain in an altered vegetated condition (i.e., early structural stage development).

There is potential for the establishment of non-native and invasive species in all habitats as a result of ROW construction, particularly in those areas where interior conditions associated with mature or old growth forests are replaced by forest openings and edge habitats. Seeds and propagules may be transported on construction vehicles, and disturbance of adjacent areas creates changes in the local environmental conditions (e.g. light availability, temperature, air flow,) that facilitate the establishment of new plants, with potential for the competitive exclusion in previously forested areas. The proposed mitigation measures (e.g., inspection of equipment before use and vegetation stabilization) will limit the potential for the introduction and establishment of non-native and invasive species in previously undisturbed forest areas. Due to the remote nature of the majority of the LSA, the local abundance of non-native and invasive seeds and propagules for introduction to those areas affected by the Project is low.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The low-risk incidents (e.g., small brush fire, localized slope failure, multiple towers failing, release of drilling mud, waste spill) could result in an effect on timber resources. Considering that these events would occur within disturbed areas (e.g., ROW) and would be small, the proposed mitigation will limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental release of hydrocarbons or other contaminants from spills or leaks may result in alteration or loss of timber resources during Project Construction. Accidental releases of hydrocarbons or other contaminants may occur during the fuelling or operation of vehicles or machinery, and are likely to be small (less than 30 L). The presence of contaminant may result in vegetation and soil bacteria mortality where they occur in native habitats. The remediation of a spill would likely require the excavation and disposal of contaminated soils, resulting in a direct loss of timber resources. The proposed mitigation measures will limit the likelihood of a release of hydrocarbon or other contaminant into the natural environment.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Timber Resources are as follows:

- Adverse because:
  - there will be a loss of the productive forest landbase where Project components affect stands of merchantable timber and / or stands that have the potential to regenerate to stands of merchantable timber.
- Of low magnitude because:
  - Effects are predicted to affect a small proportion (3%) of the total available productive forest within the LSA. Due to the remoteness of much of the Project, particularly in Central and Southeastern Labrador, the commercial value is low because the transportation costs would preclude the timber cut within the ROW from being considered merchantable.

  - At the end of the Construction phase, the ROW will remain in a vegetated albeit altered condition (i.e., varied structural stage development) with losses of productive forest landbase related to access roads, converter stations and other Project components.
- Local to regional because:
  - primarily limited to the LSA, and specifically, the footprint of the ROW, access roads and other Project components occupying areas of the productive forest landbase, but some effects (e.g., dust) could extend slightly into the RSA.
- Of far future duration because:
  - removal of the productive forest landbase (i.e., precluding the maturation of timber) on some Project components (e.g., the ROW) will extend throughout the life of the Project.

The effect of Project Construction on Timber Resources is constant over the four-year Construction period, as activities move down the line, and will be measurable during Construction.

There is a high degree of confidence that the level of effect will not be greater than predicted because the accuracy of the methods used to analyze and tabulate the existing Timber Resources within the LSA. For the purposes of the EA, the evaluation of Project effects on Timber Resources used recent NLDNR Forest Resources Branch forest inventory data (GNL 2005) incorporated into the Project's ELC, to describe the existing forest landbase and to quantify the type and volume of Timber Resources within the LSA and centre line ROW. In addition, confidence in mitigation success is high as procedures and guidelines with respect to forest management are well established through existing legislation respecting the management, clearing and protection of the forests of the province. The application of the 20% contingency on the areas of the LSA potentially affected by the Project is expected to fully capture the effects of Project Construction on Timber Resources, as a precautionary approach.

12.2.6 Operations and Maintenance

12.2.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

The following provides an evaluation of potential Project-Vegetation interactions for Operations and Maintenance as summarized in the Project interactions table (Table 12.2.3-3). Typical activities during this phase of the Project include routine line inspection and maintenance to ensure safe operation of the system, vegetation management, operation of the converter stations and electrodes, infrastructure upgrades and the replacement of facility components (i.e., major repairs). While future surface disturbances resulting from Project Operations and Maintenance will be contained within the ROW (including electrode lines), access roads and other Project components, there will continue to be potential for Project effects on Vegetation during this stage.

Reduction in habitat quantity and quality associated with habitat fragmentation (i.e., from clearing of the ROW, access roads and other Project components) will persist during Operations and Maintenance. Vegetation management is scheduled to commence in year eight after construction is complete, and then every seven years thereafter during Project Operations and Maintenance, as required. Activities will be directed towards the removal of trees (i.e., vegetation that exceeds 2 m in height at maturity) with potential to threaten the security of the system by growing into or falling onto transmission lines or other Project components. Fast-growing trees and shrubs will be controlled where they impede access, by ground (e.g., trail down the ROW) or air (e.g., emergency landing sites for helicopters) traffic, required for routine line inspections. These areas will be maintained as early successional communities.

Additionally, with completion of the Project, access to previously remote areas will be modified. At present, access to much of the LSA, particularly in Central and Southeastern Labrador, is restricted to a small number of communities in proximity to the Project and an even smaller number with direct, year round access. Improved public access to and within the LSA, and the associated increase in human activity, particularly via OHV in this remote area may result in an increase in human presence and resource exploitation (e.g., timber) and may extend beyond the Project footprint. OHV traffic is typically not limited to roads and trails, and will likely extend into other areas within or adjacent to the Project components, including habitat for listed and regionally uncommon plants, wetlands and riparian areas. OHV traffic can physically damage vegetation, erode or compact soils, introduce seeds of undesirable plant species into the LSA, cause rutting and sedimentation in wetlands and riparian areas and may be a source of contaminants (oil and fuel leaks). These disturbances can all result in changes to the composition or health of vegetation species within or adjacent to the areas affected.

Non-native and invasive species have potential to alter vegetation abundance and diversity within the LSA. Construction activities associated with the Project will result in the removal or disturbance of existing vegetation cover that could provide suitable conditions for the establishment of non-native and invasive species, and thus the potential to outcompete native species. Non-native and invasive plant material transported to the LSA on vehicles and equipment and those already present in the seed bank or in the adjacent vegetation cover will have opportunities to establish.

Mitigation measures will be employed along the ROW to limit OHV and snowmobile traffic. The specific measures to be employed will be determined after the final ROW alignment and other Project component siting / routing has been completed and will be based on the appropriateness within each specific region (proximity to cities and towns), and discussed with the NLDEC Wildlife Division. Measures typically employed for access management include installation of natural barriers in conjunction with the natural topography where practicable (e.g., placement of rock barriers, planting of tree and shrub barriers), fencing and posting of signs prohibiting trespass.

Nalcor is proposing additional mitigation measures that will be in place to avoid or minimize potential adverse effects of the Project on Vegetation during Operations and Maintenance, and include:

- Ground travel within the ROW for inspection or maintenance of the transmission line will be restricted to existing and / or approved trails. These trails will be used and maintained in accordance with the applicable regulations.
- Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of Riparian Shoreline(s) will include regular inspection and maintenance of those structures.
- Nalcor will not use sterilants as a means of vegetation control, but will rely on non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. This approach will avoid the potential for soil sterility issues. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002.
- All herbicide application will be performed by applicators certified with an "Industrial Vegetation" license issued by the NLDEC. Herbicide application will not be undertaken in PPWSAs, private or provincial parks, ecological reserves, or on private lands without permission of the owner.
- Personnel conducting vegetation control will be made aware of the known locations of listed species and their habitat. Herbicide will not be used within 30 m of these sites; maps and Global Positioning System (GPS) coordinates of locations will be provided. If non-native and invasive species are an issue in an area supporting Listed Plant species, alternative management techniques will be implemented.

- Upon completion of the Construction phase, temporary access will be assessed to determine if it will be needed for Operations and Maintenance; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the road or trail condition.
- Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally.
- Nalcor will inspect equipment required for Operations and Maintenance before use to reduce the potential for the introduction of non-native and invasive plant species.
- Vegetation buffer zones, established at environmentally sensitive areas during construction, will be maintained. Only danger trees will be removed from these areas.
- The vegetation maintenance technique will allow the root system to remain intact, allowing the soil to bind and encourage rapid colonization of low-growing plant species.
- Erosion control measures installed during or after construction will be inspected and maintained as part of Operations and Maintenance activities.
- Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products.
- Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied as applicable and will be described in the EPP.

12.2.6.2 Existing Knowledge

Several of the potential interactions between Operations and Maintenance activities and Vegetation are similar to Construction (e.g., the effects of vegetation removal). Others are unique or more prevalent in this phase including use of herbicides, increased OHV access, and introduction of non-native and invasive plant species. A review of relevant literature focusing on the existing knowledge that is pertinent to Operations and Maintenance activities, including mitigation to reduce potential effects as identified for similar projects and activities in North America is summarized in Table 12.2.6-1.

Table 12.2.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Vegetation

Reference	Study / Project Context	Summary of Findings
Natural Resource Group (NRG) (2008)	*Palomar Gas Transmission Project: Preliminary OHV Blocking Plan* An OHV blocking plan implemented on the Palomar Gas Transmission Project	– Measures are specific to the site conditions of the ROW in different regions, as determined during a preliminary assessment – Provides insight into effective mitigation used for other linear projects, including blocking techniques (e.g., fences and boulders), ROW disguising techniques (e.g., vegetation), OHV diversion techniques (e.g., OHV trail construction) and education (e.g., signage)
Nova Scotia Public Lands Coalition (NSPLC) (2006, internet site)	*Issues: ATVs & OHVs* A presentation of the effects of unrestricted use of OHVs on vegetation and wilderness. Also provides summaries of findings of studies of OHV use on wilderness and vegetation in other jurisdictions	– Off road vehicles are found to cause damage to sensitive habitats by crushing vegetation, scarring bogs and causing erosion and sedimentation in streams – Several examples are provided of rutting, sedimentation, erosion, vegetation damage and localised hydrological changes resulting from unrestricted OHV use in natural areas

Table 12.2.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Vegetation (continued)

Reference	Study / Project Context	Summary of Findings
Russo Garrido and Stanley (2002) as cited in: Department of Education, Province of Newfoundland and Labrador. (2009)	Labrador Road Study: Local knowledge on the social and environmental impacts of the newly constructed Trans-Labrador Highway (TLH) in south-eastern Labrador	– Residents in Mary's Harbour and Cartwright were surveyed about the impact of TLH, reporting no general overall effect on the location of, frequency of, or participation in domestic hunting, fishing, berry picking, or other land-use and harvesting activity – 43% interviewed reported using the road to reach traditional or new fishing and / or hunting grounds, which were mostly located near their community – In Cartwright, 80% reported not using the road for their fishing and / or hunting expeditions – Greater effect reported in relation to domestic woodcutting practices: 54% used the TLH either to find new cutting areas and / or to transport a snowmobile to traditional harvesting locations; 27% do not use the road or their trucks for woodcutting operations; one interviewee in Mary's Harbour said that the road gave access to birch stands for the first time
Smith and Prichard (1992)	*Riparian Area Management* Riparian area management techniques, including those to specifically intended to limit vehicle damage to riparian areas	– Recommends that measures be appropriate to site-specific land uses and topography – Techniques include both physical impediments to entering riparian areas (fences) and road design features to keep vehicles on the road in sensitive areas – Design of physical impediments must consider wildlife accessing riparian areas, seasonal snow depths and tree fall
Nickerson et al. (1989)	*Effects of Power-Line Construction on Wetland Vegetation in Massachusetts, USA* Documents the effects of power utility ROW maintenance on vegetation in a wooded swamp, cattail marsh and shrub bog in northern Massachusetts (winter construction)	– A stable and highly diverse shrub wetland community developed under the power lines as a result of periodic mechanical ROW maintenance following construction – Dense shrubs inhibited further growth of tree seedlings, resulting in less demand for ROW maintenance over time – Transmission line maintenance in wooded wetlands did not result in long-term damage to vegetation based on the study's community composition measures (plant diversity using Shannon - Weaver species evenness, and Margalef's species richness calculated from experimental plot data)
Magnusson and Stewart (1987)	*Effects of disturbances along hydroelectrical transmission corridors through peatlands in northern Manitoba, Canada*	– The introduction of Tordon class herbicides to control the growth of trees in the ROW had a negative environmental effect on the growth of many understorey plants, particularly the sphagnum species and low ericaceous shrubs that define this ecosystem and its functions – Herbicide applications had a longer-term environmental effect on the peatland community structure than the initial vegetation clearance practices

Table 12.2.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Vegetation (continued)

Reference	Study / Project Context	Summary of Findings
Dreyer and Niering (1986)	*Evaluation of Two Herbicide Techniques on Transmission Rights-of-Way: Development of Relatively Stable Shrublands* Article documents the commercial feasibility of the selective basal approach in ROW vegetation management in southern New England	– Post-construction vegetation management using two herbicide techniques - 1) basal and 2) stem-foliar herbicide applications, were compared over a ten year period – Study suggests that the basal approach produced a more favourable response to treatments and promoted development of stable shrubland environments frequently associated with other forested regions – Areas with greater shrub cover generally had fewer tree seedlings than herb-dominated areas – When used by commercial spray crews, the selective basal method was deemed an ecologically desirable means of encouraging the development of relatively stable shrublands, thereby decreasing the number of invading tree seedlings – Creation of stable shrublands can potentially reduce the amount of future herbicide use

12.2.6.3 Operations and Maintenance Effects: Vegetation Abundance and Diversity

Operations and Maintenance of the Project will directly affect Vegetation Abundance and Diversity through ongoing inspections and repairs of the ROW (including electrode lines), access roads and other Project components, vegetation management and as a result of OHV use of access roads. Maintenance of the ROW will involve both mechanical and chemical vegetation control techniques and will interact with vegetation abundance and diversity through habitat alteration. Such activities will be performed approximately every seven years according to the maintenance schedule, but may also occur intermittently at site-specific locations as a result of unforeseen maintenance requirements. Additional likely effects include exposure to inadvertent spills or leaks, and indirect effects related to soil compaction, rutting, alterations to surface water flow, and introduction of non-native and invasive plant species, in areas of regenerating vegetation.

Vegetation communities within the area of the ROW (including electrode lines) and other Project components not required for operations or access will remain as early successional herbaceous or shrub layer vegetation communities. These areas will be managed (every seven years) to control seedlings and those trees that are capable of reaching heights greater than 2 m at maturity. Natural revegetation of exposed mineral substrates will be encouraged. Habitat Types, such as Black Spruce Lichen Forest, Lichen Heathland, Kalmia Lichen / Heathland that are dominated by moss and lichen components of the ecosystem, will be slower to revegetate, and possibly delayed for a period of time after Construction.

As during Construction, access will be required to, and along, the length of ROW (including electrode lines) and in association with other Project components during Operations and Maintenance. There are several potential effects resulting from this access. Vehicle traffic associated with Operations and Maintenance is anticipated to be intermittent in nature (routine maintenance and inspections traffic along the ROW and other Project components); however, the use of the access roads presents the potential of airborne dust generation and particulate emissions, adversely affecting respiration of ground vegetation during the drier summer months due to dust deposition. This effect would be minor given the limited traffic anticipated during this stage. As during Construction, vehicle traffic, including increased OHV access, presents the opportunity for introduction and spread of invasive and non-native plant species.

Accidents and malfunctions could occur during Operations and Maintenance, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, multiple tower failure, localized slope failure) on vegetation abundance and diversity may result in alteration or loss of Habitat Types. Considering that these events would occur within disturbed areas (e.g., ROW) and would be limited, the proposed mitigation is will limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental spills involving hazardous materials, chemicals, and petroleum products could occur within the ROW and other Project components with potential effects on vegetation. The degree of effect or consequence of such an event, and resultant alteration or loss of vegetation is largely dependent on the nature and extent (i.e., type of material and the volume released) of the initial disturbance. A larger spill is less likely during Operations and Maintenance than during Construction due to the limited need for these materials to be on-site. Minor spills will be cleaned-up efficiently and effectively and unacceptable environmental effects are not anticipated.

If major system repairs are required, the effects would be similar to those outlined for the Construction of that component and occur over the affected length of the ROW. The mitigation outlined for the Construction phase would be applied, as appropriate, and the level of effects would be comparable to those identified for construction. The effects would be less, as repairs would be undertaken within the disturbed ROW and disturbances would be limited.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on Vegetation Abundance and Diversity are as follows:

- Adverse because:
  - there will be repairs, routine inspection and maintenance (e.g., vegetation management) to, and along, the entire length of the transmission line ROW that will limit the succession progression or limit the height of vegetation; and
  - there will likely be increased public access within the LSA, which could result in direct disturbance of vegetation and introduction and spread of non-native and invasive plant species.
- Of low magnitude because:
  - areas affected through vegetation management are anticipated to be small (i.e., <5% of a mapped Habitat Type) and will occur within previously disturbed areas (i.e., ROW and access);
  - environmental effects of public access on vegetation will be mitigated through access control measures and are predicted to result in the alteration or loss of <5% of mapped vegetation; and
  - the likelihood of spills or malfunctions during Operations and Maintenance is low and following the proposed mitigation measures and EPP for the Project will mitigate potential environmental effects of the small areas affected.
- Local to regional because:
  - effects will primarily be limited to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.
- Of far future duration because:
  - access to the ROW and other Project components will be required throughout the life of the Project; and
  - Operations and Maintenance will require regular vegetation management for system safety, throughout the life of the Project.

The effect of Operations and Maintenance on Vegetation Abundance and Diversity is intermittent and will be measurable for the life of the Project, particularly during vegetation management, routine line inspections and repairs (where applicable) and in areas of unauthorized public access.

There is a high degree of confidence that the level of effect will not be greater than predicted because criteria for the evaluation of Project effects are based on proven mitigation measures and infrequent vegetation management activities (i.e., every seven years). There is limited uncertainty associated with the potential effects of increased public access to previously inaccessible sensitive habitats because the type, location and level of potential activity are unknown. However, considering the remoteness and the lack of population centres along the majority of the Project components, particularly the ROW, the assessment is precautionary.

12.2.6.4 Operations and Maintenance Effects: Wetlands and Riparian Shoreline

The following discusses the effects of Operations and Maintenance of Project components and the ROW on Wetlands and Riparian Shoreline due to similarities in their form and response to effects. The extent of Project interactions with Wetlands and Riparian Shoreline were evaluated with respect to alteration (e.g., change in character and composition of vegetation and / or soils). Loss of Wetlands (e.g., conversion to upland, lake or pond) is unlikely to occur at this stage of the Project.

Alteration of Wetlands and Riparian Shoreline may occur as a result of ground-based inspections and repairs, vegetation management and unauthorized OHV use. Effects of vegetation management on Wetlands and Riparian Shoreline may include periodic disturbance during vegetation management (i.e., soil disturbance and crushing of vegetation by equipment), and the soil and ecological effects (e.g., changes to botanical community structure and composition, potential increase in soil exposure and change in soil chemistry due to altered botanical community or herbicide applications). The Project effects on Wetlands and Riparian Shoreline resulting from vegetation management are limited to the areas previously disturbed during Construction. In Wetlands and along Riparian Shorelines, vegetation management will be limited to the areas where, for technical reasons, vegetation must be maintained at a low height. In these areas, the alteration of Vegetation will be minimized by implementation of appropriate mitigation measures.

As discussed for the Construction phase, any permanent access roads will be routed to avoid Wetlands, waterbodies and Riparian Shorelines, wherever possible. This avoidance mitigation measure will also serve to minimize Project interactions with Wetlands and Riparian Shorelines habitat during Operations and Maintenance. During this phase of the Project, permanent access roads, as well as the ROW, may be used by the public for unauthorized recreational OHV use. Public use could lead to damage to sensitive habitats, as previously observed in Newfoundland (e.g., LBHSP 2010, internet site) and other jurisdictions (e.g., NSPLC 2006, internet site). The potential effects include increased access to currently undisturbed environments, erosion and rutting of soils, transportation of seeds of non-native invasive species to currently undisturbed environments and other forms of off-trail damage within the LSA as OHV user's access new areas. The use of OHVs within the Project components will be minimized and managed through development and implementation of access control measures.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Wetlands and Riparian Shoreline may result in alteration or loss of Habitat Types. Considering that these events would occur within disturbed areas (e.g., ROW) and would be limited, the proposed mitigation measures are likely to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Accidental release of hydrocarbons or other contaminants from spills or leaks may result in alteration or loss of Wetland or Riparian Shoreline area during Project Operations and Maintenance. Accidental releases of hydrocarbons or other contaminants may occur during the fuelling or operation of vehicles or machinery, during vegetation management or repairs and maintenance of Project components and are likely to be small (less than 30 L). Fuel transport and storage are not likely to be necessary during Project Operations and

Maintenance, and the frequency of Project maintenance activities in a particular wetland or riparian area will be low (i.e., every seven years). For these reasons, the potential for accidental spills during Project Operations and Maintenance is lower than during Project Construction. The remediation of a spill would likely require the excavation and disposal of contaminated soils, resulting in a direct loss of wetland or riparian area. The proposed mitigation measures will limit the likelihood of a release of hydrocarbon or other contaminant to a wetland (e.g., fuelling of vehicles a minimum of 50 m from a wetland or waterbody).

If major system repairs are required, the effects would be similar to those outlined for the construction of that component and occur over the affected length of the ROW. The mitigation outlined for the Construction phase would be applied, as appropriate, and the level of effects would be comparable to those identified for Construction. The effects would be less, as repairs would be undertaken within the disturbed ROW and disturbances would be limited.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on Wetlands and Riparian Shoreline are as follows:

- Adverse because:
  - there will be alteration of Wetlands and Riparian Shorelines as a result of repairs, routine inspection and maintenance for safe use and proper function of Project components (e.g., adjacent to towers and access roads);
  - there will likely be alteration of Wetlands and Riparian Shorelines as a result of increased public access along the ROW, particularly OHV use; and
  - there is potential for alteration of Wetlands and Riparian Shorelines as a result of accidental release of contaminants or the remediation of this release.
- Of low magnitude because:
  - the Wetlands and Riparian Shoreline alteration will primarily occur on previously disturbed areas (i.e., within the ROW and adjacent to access roads and towers);
  - avoidance during siting and routing of the Project components indicates that <5% of the total mapped area (Wetlands) or length (Riparian Shorelines) in the LSA by region could be affected; and
  - any spills that occur during Operations and Maintenance would be unlikely and small in nature.
- Local to regional because:
  - effects will primarily be limited to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.
- Of far future duration because:
  - access to and along the Project components (e.g., the ROW) will be required throughout the life of the Project;
  - Operations and Maintenance will require regular vegetation management to ensure system and public safety; and
  - OHV use on Project components could continue over the life of the Project (i.e., for as long as the ROW and access roads are accessible to OHVs).

The effect of Project Operations and Maintenance on Wetlands and Riparian Shorelines is intermittent and will be measurable for the life of the Project, particularly during vegetation management, routine line inspections and repairs (where applicable) and in areas of unauthorized public access.

There is a high degree of confidence that the level of effect will not be greater than predicted because of the use of proven mitigation measures and infrequency of the effects (e.g., vegetation management every seven years). There is limited uncertainty in predicting the effect Project Operations and Maintenance on OHV use in the ROW, and the effectiveness of proposed mitigation measures. The number and interest of local OHV users that may use the ROW and the response of OHV users to education programs and physical impediments to OHV use is not known. This will be addressed during the preparation and implementation of access control measures.

12.2.6.5 Operations and Maintenance Effects: Listed and Regionally Uncommon Plants

While vegetation management activities will occur in the ROW during Operations and Maintenance, this will occur in areas already cleared during Construction. Listed and Regionally Uncommon Plants will still be sensitive to this occasional disturbance, as well as other periodic inspection and maintenance activities, but it will be of lesser consequence than during Construction, as activities will be periodic and less intensive. Mitigation measures applied during Construction (i.e., avoidance to the extent practical and pre-construction surveys) will limit the potential for interactions during Operations and Maintenance. However, there is still potential for previously undetected Listed or Regionally Uncommon Plant species to occur within or along the ROW or near other Project components, or for changes in vegetation composition associated with the ROW to encourage growth of non-native invasive species. In these cases, continued disturbance may result from ground-based inspections and maintenance, vegetation management and unauthorized access (i.e., OHV access) and use (resource harvesting) of the ROW. Vegetation maintenance will occur at seven year intervals and will involve various control mechanisms. Effects of vegetation management on these plants and their habitat may include periodic disturbance during mechanical vegetation management (i.e., soil disturbance and crushing of vegetation by equipment), soil and ecological effects (e.g., changes to botanical community structure and composition, potential increases in soil exposure and change in soil chemistry due to altered botanical community or herbicide applications).

During Operations and Maintenance, the majority of forested Habitat Types disturbed for construction of the Project will no longer provide the environmental conditions that existed prior to clearing. However, this habitat alteration may in fact be of benefit to a small subset of ACCDC target list species whose particular habitat requirements favour recently disturbed habitats (i.e., *Botrychium multifidum*, *B. matricariifolium, B. lanceolatum*). Based on recent analysis of sighting reports for these species (Stantec 2010d), there seems to be a narrow variation in the habitat preference for each of *B. multifidum*, *B. matricariifolium, B. lanceolatum*, within their known range in Central and Southeastern Labrador. Of locations identified during 2010 botanical surveys, the majority of occurrences were for *B. multifidum*, with individuals of *B. Matricariifolium* and *B. lanceolatum* scattered throughout. Disturbed, sandy ground and roadside ditches in the early stages of recolonization by a variety of low-growing herbaceous perennials and often a sparse to moderate cover of Cladonia lichens were preferred. Throughout its range, the Project is likely to affect similar areas of potential habitat thereby potentially contributing to the creation of suitable habitat for *Botrychium spp.* within the ROW, and other Project components.

Transmission corridors, access roads and other Project components could potentially provide increased access for the public, which could lead to disturbance in and around sensitive habitats (e.g., limestone barren ecosystems of the Northern Peninsula). This includes potential for off-trail damage to Listed Species (e.g., Long's braya, Fernald's braya) and their important habitats within the LSA as a result of OHV users accessing new areas. However, as previously observed by the LBHSP (2010, internet site), these areas have already been disturbed by human activity. There are laws (i.e., *SARA, NLESA*) that restrict damage and destruction of sensitive habitats by any means, including that of OHV use, but enforcement is often difficult over a large area. Varied mitigation techniques can be used to prevent or reduce unwanted OHV access to sensitive habitats (e.g., LBHSP 2010, internet site), with involvement of local community groups being a fundamental aspect.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure) on listed plants and regionally uncommon plants may result in alteration or loss of Habitat Types. Considering that these events would occur within disturbed areas (e.g., ROW) and would be limited, the proposed mitigation is expected to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Lower likelihood for accidental spills of hydrocarbons or hazardous materials exists during Operations and Maintenance as the volumes and frequency of use of equipment will be reduced. The degree of effect or consequence associated with such an event, and resultant adverse effect on Listed Plants and Regionally Uncommon Plants would be largely dependent on the nature and extent (i.e., type of material and the volume released) of the disturbance. Any spill would likely be small, and within a previously disturbed area. With the planned mitigation, environmental effects would likely be limited.

If major system repairs are required, the effects would be similar to those outlined for the construction of that component and occur over the affected length of the ROW. The mitigation measures outlined for the Construction phase would be applied, as appropriate, and the level of effects would be comparable to those identified for Construction. The effects would be less, as repairs would be undertaken within the disturbed ROW and disturbances would be limited.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on listed and regionally uncommon plants are as follows:

- Adverse because:
  - Listed or Regionally Uncommon Plants could be disturbed or lost as a result of vegetation management, vehicle traffic associated with repairs, routine inspection and maintenance activities, or increased public OHV use.
- Of low magnitude because:
  - the area affected by vegetation management will occur primarily on previously disturbed areas (i.e., ROW and access) and will be <5% of the mapped habitat types;
  - the effects of public access will be managed through Nalcor's access control measures; and
  - any accidental spills would likely be infrequent and small and following the proposed mitigation measures and EPP for the Project will mitigate potential environmental effects of accidental events.
- Local to regional because:
  - effects will primarily be limited to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.
- Of far future duration because:
  - access to the corridor will be needed throughout the life of the Project;
  - Operations and Maintenance will require regular vegetation management to ensure system and public safety; and
  - unauthorized OHV use will likely occur throughout the life of the Project.

The effect of Project Operations and Maintenance on Listed and Regionally Uncommon Plants is intermittent and will be measurable for the life of the Project, particularly during vegetation management, routine line repairs (where applicable) and in areas of unauthorized public access.

There is a high degree of confidence that the level of effect will not be greater than predicted due to the use of proven mitigation measures and the infrequent occurrence of the activities required for Operations and

Maintenance of the Project. There is limited uncertainty associated with the potential effects of increased public access to previously inaccessible sensitive habitats because the type, location and level of activity are unknown. However, considering the remoteness and the lack of population centres along the majority of the Project components, particularly the ROW, the assessment is precautionary.

12.2.6.6 Operations and Maintenance Effects: Timber Resources

While vegetation management activities will occur in the ROW during Operations and Maintenance, this will occur in areas already cleared during Construction. During Operations and Maintenance, the ROW will be maintained in a vegetated albeit altered condition (i.e., early structural stage development). Re-establishment / renewal of those areas previously characterized by forested Habitat Types will be allowed, though controlled to ensure the safe operation of the transmission system, maintaining the landbase in a "pioneer" or young successional stage. During Construction topsoil is often disturbed, compacted, or removed. Although not always immediately apparent, damage to tree roots, with potential effects on overall tree health, may result.

The presence and continued use of access roads represents another potential source of effects on Timber Resources. Uncontrolled OHV access by the public, to, and along the ROW, with increased opportunities for the illegal harvesting of Timber Resources has the potential to contribute to additional effects on mature and old growth forests.

Indirect effects of ROW clearing associated with altered natural disturbance regimes (i.e., forest fires, outbreaks of defoliating insects, disease, and occasionally windthrow events (blow down of trees due to wind)) are likely to persist throughout Operations and Maintenance of the transmission system, each with varying potential effects on Timber Resources. Burton (2002) looked at the effects of clearcut edges on trees in the Sub-Boreal Spruce Zone of Northwest-Central British Columbia and observed that opening effects on trees can extend between 40 and 120 m into this forest type. Chen et al. (1992) considered responses of old growth Douglas-fir forests to edge environments and found that for variables including reduced stocking density, increased growth rates of dominant Douglas-fir and western hemlock and elevated rates of tree mortality, the depth-of-edge influence (i.e., point at which variable returns to condition representing two-thirds of the interior forest environment) ranged from 16 to 137 m. Where the Project affects mid- to late-successional forest habitats, transmission line ROWs, access roads and trails, will contribute to the size and extent of forest openings. This will increase the edge to interior conditions associated with forest openings and mature forest, increasing the area of edge habitats and thus introducing edge effects along Project components, particularly the transmission line ROW. The effect of forest openings on adjacent edge-influenced habitat varies. Significant differences in natural regeneration, seedling establishment, and tree growth are known to be associated with distance from stand edges (Hansen et al. 1993).

Vegetation management activities will include removing trees with the potential to interact with the conductors and affect the safe operation of the transmission system, including those trees considered hazardous that may occur along the ROW. It is anticipated that tree removal would be necessary on a site-by-site basis and that Nalcor would continue to perform maintenance and clearing of potential hazardous trees from the existing ROW, and that the natural conditions of mortality and deadfall will likely regenerate affected areas into new, young forests.

Accidents and malfunctions could occur during Operations and Maintenance, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure) on Timber Resources may result in alteration or loss of Habitat Types. Considering that these events would occur within disturbed areas (e.g., ROW) and would be limited, the proposed mitigation measures are expected to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants.

Lower potential for accidental spills of hydrocarbons or hazardous materials exist during Operations and Maintenance as the volumes and frequency of use of equipment will be reduced. The degree of effect or consequence associated with such an event, and resultant adverse effect on Listed Plants and Regionally Uncommon Plants would be largely dependent on the nature and extent (i.e., type of material and the volume released) of the disturbance. Any spill would likely be small, and within a previously disturbed area. With the planned mitigation measures, environmental effects would likely be limited.

If major system repairs are required, the effects would be similar to those outlined during the Construction of that component and occur over the affected length of the ROW. The mitigation measures outlined for the Construction phase would be applied, as appropriate, and the level of effects would be comparable to those identified for Construction. The effects would be less, as repairs would be undertaken within the disturbed ROW and disturbances would be limited.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on Timber Resources are as follows:

- Adverse because:
  - the productive forest landbase crossed by the ROW (including electrode lines) will be maintained in an early successional stage (i.e., pioneer or young);
  - there will be increased public access within the LSA in terms of the enhanced accessibility afforded by access trails and roads, which is conducive to increased unauthorized use and consumption of Timber Resources; and
  - indirect effects of ROW clearing, including forest fires, outbreaks of defoliating insects, disease, and occasionally windthrow events are likely to persist throughout Operations and Maintenance.
- Of low magnitude because:
  - the area affected by vegetation management is <5% of timber resources mapped in the LSA and will occur on previously disturbed areas (i.e., 60 m ROW, access roads and access trails); and
  - the effects of public access will be managed through Nalcor's access control measures.
- Local to regional because:
  - effects will primarily be limited to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.
- Of far future duration because:
  - unauthorized public access to the corridor may occur throughout the life of the Project; and
  - Operations and Maintenance will require regular vegetation management to ensure system and public safety.

The environmental effect of Project Operations and Maintenance on Timber Resources is intermittent and will be measurable for the life of the Project, particularly in areas where unauthorized public access facilitates domestic cutting.

There is a high degree of confidence that the level of effect will not be greater than predicted because of the use of proven mitigation measures and infrequent occurrence of the activities required for Operations and Maintenance of the Project. However, there is uncertainty associated with potential effects of increased public access to previously inaccessible areas.

12.2.7 Environmental Effects Summary and Evaluation of Significance

Effects of the Project on Vegetation were assessed by selecting KIs and specific MPs. These indicators address specific vegetation-based issues such as likely Project effects to Vegetation Abundance and Diversity, Wetlands, Riparian Shorelines, Listed and Regionally Uncommon Plants and Timber Resources.

12.2.7.1 Summary of Environmental Effects

A comparative summary of the Project effects analysis for Vegetation is provided in Table 12.2.7-1. The summary provides the likely Project effects on each KI, based on an evaluation of the environmental effects descriptors described above.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Vegetation Abundance and Diversity	**Adverse** – Degradation and alteration or loss of a proportion of each Habitat Type is likely within the ROW. – Fragmentation of habitats will contribute to altered natural disturbance regimes with potential increases in the frequency of forest fires, outbreaks of defoliating insects, disease, pathogens and windthrow events. – Movement of personnel and equipment could lead to potential spills and malfunctions. – Improved access to previously remote areas with potential for resource exploitation.	**Low** – Effect limited to less than 5% of available Habitat Types within the LSA and effects are not likely to cause measurable changes to Habitat Types intersected by the ROW.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	– Effects will occur once during the Construction phase. – Effects from vehicle traffic and increased access (i.e., OHV use) will be ongoing. – Effects of accidental spills and malfunctions will be infrequent.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Wetlands	**Adverse** – There will likely be alteration or loss of Wetlands where, for technical reasons, it is not possible to avoid wetlands during ROW route selection and site selection for Project components or where mitigation does not completely eliminate the effects of construction.	**Low** – Effect to less than 3% of available wetland area within the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Medium-term to Far Future** – Effects to wetlands crossed in the winter will recover within 4 yrs. – Effects to wetlands crossed during unfrozen periods could take 10 years to recover. – Effects will be evident throughout the life of the Project where components (e.g., towers or access) are built in wetlands.	– Effects will occur once during the Construction phase. – Effects from vehicle traffic and increased OHV use will be ongoing. – Effects of accidental spills will be infrequent.
Riparian Shoreline	**Adverse** – There will be alteration of Riparian Shoreline (e.g., at a necessary fording sites or where an access road crosses a watercourse).	**Low** – Effect to less than 5% of available Riparian Shoreline within the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	– Effect associated with clearing, grubbing and grading will occur once during the Construction phase. – Effects from vehicle traffic and increased OHV use will be ongoing. – Effects of accidental spills will be infrequent.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Listed Plants	**Adverse** – Loss of individual Listed Plants, while mitigated, may occur as a result of direct disturbance, accidental spills and malfunctions, and uncontrolled OHV access. – Alteration or loss of important habitat. – Potential fragmentation of important habitats may contribute to altered natural disturbance regimes and changes in environmental conditions leading to increased plant pathogens and disease.	**Low** – Effect limited to less than 5% of known listed plant locations within the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	– Effect associated with clearing, grubbing and grading will occur once during the Construction phase. – Effects from vehicle traffic and increased access (i.e., OHV use) will be ongoing. – Effects of accidental spills and malfunctions will be infrequent.
Regionally Uncommon Plants	**Adverse** – Degradation and alteration or loss of a proportion of Habitat Types, rated High and Very High leading to the potential loss of individual Regionally Uncommon Plants. – Potential fragmentation of important habitats may contribute to altered natural disturbance	**Low** – Effect limited to less than 5% of available Habitat Types, rated High or Very High, within the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects of habitat loss will be evident throughout the life of the Project.	– Effect associated with clearing, grubbing and grading will occur once during the Construction phase. – Effects from vehicle traffic and increased access (i.e., OHV use) will be ongoing. – Effects of accidental spills and malfunctions will be infrequent.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
	regimes and changes in environmental conditions leading to increased plant pathogens and disease. – Movement of personnel and equipment leading to potential spills and malfunctions. – Improved access to previously remote areas with potential for resource exploitation.				
Timber Resources	**Adverse** – Degradation and alteration or loss of commercially-viable, productive forest landbase. – Improved access to previously remote areas will result in resource exploitation (i.e., domestic cutting) within the LSA and potentially beyond.	**Low** – Effects limited to less than 5% of available merchantable timber within the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	– Effect associated with clearing, grubbing and grading will occur once during the Construction phase. – Effects from vehicle traffic and increased access (i.e., OHV use) will be ongoing. – Effects of accidental spills and malfunctions will be infrequent.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Summary of Likely Residual Construction Effects on Vegetation: For the Vegetation VEC, Construction activities that result in clearing or disturbance of vegetation, or those that result in the disturbance of Wetlands, Riparian Shoreline and those habitats supporting populations of Listed or Regionally Uncommon Plant species have the greatest likelihood to contribute to adverse effects. Construction activities will likely lead to local, low magnitude direct and indirect disturbances to vegetation, resulting from clearing, soil disturbance, drainage alteration and inadvertent spills resulting in site-specific contamination. The predicted limited nature of these effects is based on the application of proven, accepted mitigation methods and approaches.					
Operations and Maintenance					
Vegetation Abundance and Diversity	**Adverse** – No additional loss of Habitat Types; however, Habitat Types will be maintained (limit the succession progression and height of vegetation) in an early successional stage for the duration of the Project. – Fragmented habitats will continue to contribute to altered natural disturbance regimes with potential increases in the frequency of forest fires, outbreaks of defoliating insects, disease, pathogens and windthrow events. – Improved access provided by the ROW will increase potential for disturbance of Habitat	**Low** – Effects limited to less than 5% of available Habitat Types within the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	**Intermittent** – Effects may occur intermittently as a result of enhanced access, non-native and invasive species establishment, and / or accidental spills.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
	Types or components of those Habitat Types (i.e., birch component of mixedwood stands) desired for fuel wood but not previously accessible.				
Wetlands and Riparian Shoreline	**Adverse** – Alteration of Wetlands and Riparian Shoreline can result from periodic vegetation management required for safe use and proper function of Project components (e.g., ROW, adjacent to towers and access roads). There will likely be alteration of Wetlands and Riparian Shoreline as a result of increased public access along the ROW, particularly OHV use.	**Low** – The Wetland and Riparian Shoreline alteration will occur on previously disturbed areas, which was expected to be less than 5% of total occurrence in the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project where components (e.g., towers and access) are built in wetlands.	**Intermittent** – Effects from vegetation maintenance will occur periodically (every eight to ten years as needed) throughout the life of the Project. Effects from OHV access will likely be seasonal.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Listed Plants / Regionally Uncommon Plants	**Adverse** – No additional loss of Habitat Types; however, Habitat Types will be maintained (limit the succession progression and height of vegetation) in an early successional stage for the duration of the Project. – Fragmented habitats will continue to contribute to altered natural disturbance regimes and changes in environmental conditions with potential increases in the frequency of forest fires, outbreaks of defoliating insects, disease, pathogens and windthrow events. – Improved access to previously remote areas could lead to the disturbance or loss of yet known individuals or populations of these plants due to increased human activity.	**Low** – Effects limited to less than 5% of known listed plant locations and available Habitat Types, rated High or Very High, within the LSA.	**Local to Regional** – Effects will primarily be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	**Intermittent** – Effects may occur intermittently as a result of enhanced access, non-native invasive species establishment, and / or accidental spills.
Timber Resources	**Adverse** – No additional loss of	**Low** – Effects limited to less	**Local to Regional** – Effects will primarily	**Far Future** – Effects will be evident	**Intermittent** – Effects may occur

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
	productive forest landbase; however, vegetation will be maintained (i.e., forested Habitat Types will remain in a vegetated albeit managed condition) in an early successional stage for the duration of the Project limiting or precluding the regeneration of forested areas. – Fragmented habitats will continue to contribute to altered natural disturbance regimes and changes in environmental conditions with potential increases in the frequency of forest fires, outbreaks of defoliating insects, disease, pathogens and windthrow events. – Improved access to previously remote areas will result in resource exploitation (i.e., domestic cutting) within the LSA.	than 5% of available merchantable timber within the LSA.	be confined to the LSA, but some effects (e.g., dust) could extend slightly into the RSA.	throughout the life of the Project.	intermittently as a result of enhanced access, and the un-permitted harvesting of Timber Resources.

Table 12.2.7-1 Environmental Effects Analysis Summary: Vegetation (continued)

Project Phase / Key Indicator	**Likely Residual Environmental Effects Summary Descriptors**				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Summary of Likely Residual Operations and Maintenance Environmental Effects on Vegetation: For the Vegetation VEC, Operations and Maintenance activities will likely lead to local, low magnitude, direct and indirect disturbances to Vegetation, resulting from intermittent vegetation management, increased access for OHVs and the resultant disturbance to potentially sensitive habitats or mismanagement of the resource (i.e., illegal harvesting); spread of non-native or invasive plant species; and inadvertent spills resulting in site-specific contamination. The limited nature of these effects considers the application of proven, accepted mitigation methods and approaches.					

12.2.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level.

As a critical part of all ecosystems in the province, plants provide oxygen and are the basis of most food webs providing habitat for wildlife. Plants also clean and filter water, help prevent soil erosion and reduce air pollution, by acting as carbon sinks through their uptake of carbon dioxide. Plants also feature prominently in local Aboriginal culture. Vegetation communities, particularly those of mature and old growth forests, contribute to the provincial economy through the provision of timber resources. A host of vegetation communities throughout the province are used for both recreational and subsistence purposes. Maintenance of vegetation and vegetation communities as healthy, productive components of the natural environment in a sustainable fashion will allow for the continued ecological, social and economic role of this VEC into the future.

A significant effect on the Vegetation VEC is defined as an effect on one of the KIs such that their continued contribution to ecosystem function within the LSA and the RSA are not sustainable. An environmental effect that does not meet these criteria is not significant.

Alteration or loss of habitat, or more specifically the extent to which vegetation and vegetation communities are affected by the physical disturbance of the Project, was the measurable effect of greatest importance in determining the effect of the Project on the KIs chosen to represent Vegetation. The Project is expected to result in the loss of less than 5% of habitat in the LSA. The magnitude of effects on Vegetation within the LSA resulting from the Project are low, as the area of a given Habitat Type potentially affected by physical disturbance associated with the ROW and other Project components is low (i.e., relative to the area available within the LSA). Vegetation within the cleared ROW (including electrode lines), particularly those Habitat Types occurring in the late successional stages (i.e., Black Spruce Lichen Forest, Conifer Forest, Hardwood Forest, Mixedwood Forest, Open Conifer Forest), will be maintained in an early successional stage throughout the life of the Project.

Changes to Vegetation within Newfoundland and Labrador are likely to be limited to the Project components within the LSA, with limited alteration or loss to existing Habitat Types and plant species (including Listed and Regionally Uncommon Plant species). All current vegetation species and Habitat Types within the RSA and LSA will continue to be represented, with limited effects expected on biodiversity predicted as a result of the Project.

A low proportion (less than 5%) of Wetland habitat will likely be affected in the LSA as a result of the Project. The Project will not result in the loss of any particular Wetland type (class and form), or its associated functions, in the LSA. All Wetland types (class and form) currently represented in the LSA will be represented after Project Construction and will not be lost during Operations and Maintenance.

A low proportion (i.e., less than 5%) of Riparian Shoreline length in the LSA has the potential to be affected as a result of the Project. Riparian Shoreline will be avoided to the extent practical in the routing of the ROW and in site selection for Project components (e.g., access roads, tower foundations, and electrode sites). In any situations where Riparian Shoreline is not avoidable due to technical reasons (e.g., necessary watercourse crossing or fording site), alteration will be minimized to the extent practical by implementing proven mitigation measures. The Project effects on Riparian Shoreline are likely to be primarily to treed vegetation. This means that the majority of the functions of Riparian Shorelines related to bank stability, erosion control, and water filtration will continue to occur within areas affected by the Project. Where effects result in a loss of Riparian Shorelines vegetation, proven mitigation methods will protect water resources.

A significant effect on Listed Plants is one that results in the loss of more that 5% of a *SARA* or *NLESA*-listed plant population, other permanent loss of more that 5% of important habitat required by those species within the LSA leading to non-compliance with federal and / or provincial *Acts*, regulations or guidelines related to listed plants. No thresholds exist from which to assess the potential alteration or loss of individual Listed Plants or plant populations, however, an accepted guideline in the collection of vascular and non-vascular plant specimens (ANPC 2006, internet site) is that an immediate population can withstand the loss of 1 in 20 individuals or 5% of a known population.

Disturbance is not likely to have a significant adverse effect on Listed Plants in the LSA because proven, accepted mitigation practices and avoidance of known locations to the extent practical are part of the Project design and the selection process for the final ROW, access roads and other Project infrastructure. Most disturbance events are infrequent and of relatively short duration. None of these facilities will be established in areas of important habitat, such as the limestone barrens of the Northern Peninsula without prior surveys and development of appropriate mitigation for these species.

Habitat Types rated as High and Very High to support Regionally Uncommon Plants will be surveyed by qualified botanists, and site-specific mitigation measures identified, as appropriate. As such, effects on Regionally Uncommon Plant species are expected to be minimal, as proven, accepted mitigation practices and avoidance to the extent practical or minimal disturbance of known locations of these plants will be incorporated during Project design and ultimately the final selection process for the ROW and other Project components.

In all regions, the effects of the Project on Timber Resources are expected to be minimal, as the proportion of productive forest landbase is low. In Newfoundland and Labrador, the Project is anticipated to affect a low proportion (i.e., less than 5%) of productive forest landbase with 24 km^2 of the 735 km^2 (3%) potentially affected. Also, proven and accepted mitigation practices to minimize potential direct and indirect effects on Timber Resources are part of the Project design and the selection process for the final ROW and other Project components. It is predicted, that habitat capable of supporting Timber Resources, will continue to be present in the ROW post-construction; however, the landbase will be altered and maintained throughout the life of the Project in a “managed” condition.

The Project is not likely to result in an effect on any of the KIs listed above, such that their continued contribution to ecosystem function within the LSA and the RSA cannot be sustainable. Therefore, the Project is not likely to result in significant adverse environmental effects on Vegetation.

12.2.8 Evaluation of Project Alternatives

A summary of the likely effects to Vegetation by comparing the effects of the Project on the alternative segments and the proposed transmission corridor is provided in Table 12.2.8-1. The comparison is based on the predicted Project effects on each KI, in terms of area or length.

Alternative segments A4 and A7 + A8 are the only options where further evaluation is warranted from a Vegetation perspective. Alternatives A2, A5, A6, and A7 present no measurable difference in the overall area of affected habitat or disturbance to individual species over that of the preferred corridor. The remaining alternatives, including alternative segments A3, A9, A10 and A11 will likely have greater effects on Vegetation.

With respect to the alternative segments in Central and Southeastern Labrador, A2 presented no measurable difference in the area of affected habitat or disturbance to individual species. Conversely, environmental concerns are associated with alternative segment A3 which includes the presence of a federally and provincially listed species - Fernald’s milk-vetch.

In Newfoundland, the majority of alternatives present no measurable difference in the area of habitat affected and no disturbance to individual plant species of concern is likely. However, alternatives A9 and A10 in Central and Eastern Newfoundland will affect considerably more habitat associated with the KIs of Vegetation Abundance and Diversity, Wetland and Riparian Shoreline. Similar to the environmental concerns associated with A3, alternative segment A11, has potential to intersect marginally more habitat for federally and provincially listed species – boreal felt lichen, and will likely have greater effects on Vegetation.

Table 12.2.8-1 Summary Evaluation of Project Alternative Means: Vegetation

Project Alternative Means[a]	Environmental Implications (compared to the proposed transmission corridor)[b] (positive [c], neutral[d], negative[e])					
	Vegetation Abundance and Diversity	Wetlands	Riparian Shoreline	Listed Plant Species	Regionally Uncommon Plant Species	Timber Resources
A2: North-west of Strait of Belle Isle Alternative Segment	Neutral	Positive	Neutral	Neutral	Neutral	Positive
A3: Point Amour Alternative Segment	Neutral	Negative	Negative	Negative	Neutral	Positive
A4: Strait of Belle Isle Newfoundland Side Alternative Segment	Negative	Positive	Negative	Positive	Positive	Neutral
A5: Great Northern Peninsula (GNP) North-east Alternative Segment	Neutral	Positive	Negative	Neutral	Neutral	Neutral
A6: GNP West-central Alternative Segment	Positive	Neutral	Negative	Neutral	Neutral	Neutral
A7: GNP Eastern Long Range Mountain (LRM) Crossing Alternative Segment	Neutral	Positive	Positive	Neutral	Neutral	Positive
A7: GNP Easter LRM Crossing Alternative Segment +A8: GNP International Appalachian Trail Newfoundland and Labrador Alternative Segment	Negative	Positive	Positive	Neutral	Neutral	Negative
A9: Birchy Lake Alternative Segment	Negative	Negative	Negative	Neutral	Neutral	Neutral
A10: Newfoundland and Labrador Outfitters Association Alternative Segment	Negative	Insufficient Data	Negative	Neutral	Neutral	Negative
A11: Avalon Alternative Segment	Positive	Negative	Neutral	Negative	Negative	Positive

(a) As identified and described in Chapter 2, Project Rationale and Planning,
(b) The proposed Project described in the EIS Project Description Chapter 3, and assessed in the preceding Environmental Effects Analysis.
(c) Positive = Alternative segment will have a lesser effect on the VEC.
(d) Neutral = Alternative segment and proposed segment will result in approximately equal Project effects to the VEC.
(e) Negative = Alternative segment will have a greater effect on the VEC.

12.2.9 Cumulative Environmental Effects

Cumulative effects are the overall effect on the VEC as a result of the Project's residual environmental effects that overlap both temporally and geographically with those of other projects and activities.

The environmental effects of past and existing projects and activities are captured in the baseline conditions (i.e., existing environment). Vegetation affected by Project components in Labrador exists generally in a natural pattern (i.e., has not been subject to anthropogenic disturbances), except for the portion along the TLH3. Throughout much of Newfoundland, the transmission corridor crosses or follows areas of previous disturbance, including forest harvesting, highways (e.g., provincial highway 430, the TCH, provincial highway 360, various regional routes), and existing transmission line ROWs (e.g., Nalcor's transmission line infrastructure on the Avalon Peninsula).

The likelihood of cumulative effects as a result of ongoing and future projects is the focus of this cumulative effects assessment. The following future projects and activities with likely overlapping environmental effects within the RSA were considered for the cumulative effects assessment:

- Lower Churchill Hydroelectric Generation Project – flooding for the reservoir will result in loss of vegetated habitat in the area of the lower Churchill River valley. Loss of vegetation within the reservoir will be permanent and could act in a cumulative manner with the Vegetation KIs in Central and Southeastern Labrador, particularly with respect to Riparian Shoreline habitat. It also requires construction of access roads which will increase public OHV access.
- TLH3 – construction of the TLH3 resulted in many of the same effects on Vegetation that will result from the proposed Project. Routing of the transmission line ROW to follow the TLH3 for at least part of its length within Central and Southeastern Labrador will minimize the overall cumulative effects of these two projects on vegetation abundance and diversity. The highway has been operational since 2009, so the potential for future cumulative effects are largely related to increased public and OHV access to sensitive habitats and timber resources, and potential for introduction and spread of non-native and invasive species. The former effect would likely be greatest in proximity to communities, while the latter could extend along the length of both corridors. There is already some evidence that the presence of the TLH3 has contributed to expansion of domestic cutting (Russo Garrido and Stanley 2002). The effect of the TLH3 on sensitive habitats such as wetlands and riparian habitat has not been documented.
- 5 Wing Goose Bay Military Flight Training – flight activity will occur to the north and west of the Project and no cumulative effects are anticipated on vegetation.
- Commercial Forestry Activity – the LSA crosses FMDs in both Central and Southeastern Labrador and in Newfoundland. There are several effects from the forestry industry that could act cumulatively with the Project. This includes alteration or loss of vegetation, fragmentation of vegetation communities, displacement of natural vegetation due to the introduction and spread of non-native and invasive species, alteration or loss of sensitive habitat such as Wetlands, Riparian Shoreline areas and Listed and Regionally Uncommon Plants species and increased access for the public and OHVs.

Table 12.2.9-1 shows the total allowable cut for the FMDs crossed by the Project and as available through accessible Five-year Operating Plans (NLDNR 2011, internet site). For this Project, the GMV of productive forest (softwood / hardwood) within the hypothetical 60 m wide centre line ROW (including 20% contingency) likely to be affected in Newfoundland and Labrador is 145,441 m^3. By way of comparison, this amount of timber represents 6% of the current annual allowable cut in Newfoundland and Labrador (NLDNR 2011, internet site), and less than 2% of the total volume of timber that is approved to be harvested in the most recent 5-year forest management plan.

Table 12.2.9-1 Total Allowable Cut for Forest Management Districts Crossed by the Project

Forest Management District	Timeframe for Plan	Total Allowable Cut (m^3) (Spatial Net)
21	2007-2011	243,500
19a	2008-2012	200,000
17	2008-2012	Class 1: 46,700 Class 3: 8,400 Class 3 (Soufllets): 16,000 Hardwood: 8,000
18	2008-2012	Total Softwood: 120,800 Total Hardwood: 11,700
16	2007-2011	Crown Softwood: 24,700 Crown Hardwood: 2,460 Linerboard Softwood: 20,300 Linerboard Hardwood: 2,050
9	2007-2011	Total Class 1: 25,300 Total Class 3: 36,100 Crown Hardwood: 9,450 Linerboard: 700
6	2007-2011	Class 1 Softwood: 257, 600 Class 3 Softwood: 9,780 Class 1 White Birch: 1,890 Class 3 White Birch: 70
4	2007-2011	Class 1 Softwood: 40,500 Class 3 Softwood: 11,200 Class 1 White Birch: 521 Class 3 White Birch: 110
2	2007-2011	Class 1: 79,690 Class 3: 12,900 Hardwood (AAC+Residual): 3,120
1	2007-2011	77,087

Source: NLDNR 2011, internet site.

Table 12.2.9-2 indicates the available plans for construction and decommissioning of access roads within the FMDs crossed by the Project. This does not account for existing access roads. It is estimated that by 1999, forest access roads in the province totalled more than 2,430 km and that in total (access roads built by forestry companies, the provincial Crown Lands Department and private contractors) approximately 500 km of new roads are constructed in the province annually (NLDE 2009). Given that access will be required for the Project, and given the length of the ROW, this will contribute to the cumulative effect on Vegetation.

Table 12.2.9-2 Planned Access Road Construction and Decommissioning for Forest Management Districts Crossed by the Project

FMD	Timeframe for Plan	New Access Roads	Access Road Decommissioning
21	2007-2011	16.5 km	Detailed review of access roads program will be undertaken at the end of the planning period
19a	2008-2012	73 km	No decommissioning of major access roads - decommissioning of operational roads within harvest blocks will be carried out once the planned activities are completed
21	Not available as plan is ongoing	Not available as plan is ongoing	Not available as plan is ongoing
17	2008-2012	47.9 km	Consideration given to decommissioning when activities completed
18	2008-2012	180.3 km	Consideration given to decommissioning when activities completed
16	2007-2011	Only short-term operational roads	Not applicable
9	2007-2011	86.2 km	Not defined
10	Not available as plan is ongoing	Not available as plan is ongoing	Not available as plan is ongoing
11	Not available as plan is ongoing	Not available as plan is ongoing	Not available as plan is ongoing
6	2007-2011	11 km	Road-specific - decommissioning is to be considered on an area specific basis should a conflict of values exist
4	2007-2011	87.6 km	Road-specific - decommissioning is to be considered on an area specific basis should a conflict of values exist
2	2007-2011	93 km	Decommissioning confined to secondary haul roads
1	2007-2011	Not defined	Not defined

Source: NLDNR 2011, internet site.

Other projects with effects that do not act cumulatively with the residual effects of the Project on the Vegetation VEC include:

- General Economic and Infrastructure Development – infrastructure projects, such as road maintenance and construction, municipal works, and industrial construction, often have localized, short-term construction periods, and are not likely to contribute to cumulative effects on Vegetation. Even a large construction project will likely be limited in scope to currently populated and / or disturbed areas. As well, standard construction mitigation in relation to erosion and sedimentation prevention for construction in proximity to wetlands and watercourses would serve to limit potential effects on vegetation.
- Proposed Labrador West Mining Related Developments – these developments do not overlap spatially with the Project, and therefore no cumulative effects are anticipated.
- Parsons Pond Oil and Gas Exploration Drilling – a 5 km access road and three active drill sites on the Northern Peninsula near Parson’s Pond could affect Vegetation, but activities would not likely overlap with the proposed Project. Construction of the access road, installation and operation of the drill rig, and dismantling and transportation of the drill rig are anticipated to occur within the next 1 to 2 years, so the majority of activities, with the exception of periodic well testing, will be completed before this Project commences. The access road, however, could have a combined impact with Project infrastructure, as it will contribute to increased access to previously remote areas.

- Long Harbour Processing Plant – activities are not in the proximity of the RSA, so it is unlikely to contribute to cumulative effects on Vegetation with the Project.
- Maritime Link – this development does not overlap spatially with the Project, is not in proximity to the RSA, and, therefore, no cumulative effects are anticipated.
- Oil and Gas Development Activities – these developments do not overlap spatially with the Project, and therefore no cumulative effects are anticipated.

The effects of the Project in combination with other projects and activities that have been or will be carried out are not expected to threaten the sustainability of the Vegetation KIs' contribution to ecosystem function within the RSA. Therefore, significant cumulative effects on the Vegetation VEC are not likely to occur. The planning, consultative and effect management measures identified for this VEC will serve to avoid or reduce potential interactions and adverse effects as a result of the Project. Avoiding or managing potential effects on Vegetation resulting from other ongoing and future projects and activities will require that appropriate resource management, planning, regulatory and enforcement measures are in place and implemented by the relevant agencies.

A description and determination of the likely cumulative environmental effects of the Project in each geographic region are provided in Table 12.2.9-3.

Note, all other projects or activities listed in Table 9.3.9-2, are not considered in the cumulative effects assessment on Vegetation as these developments do not overlap spatially with the Project and are not in proximity to the RSA, and therefore no cumulative effects are likely.

Additional mitigation is not considered to be necessary to eliminate or reduce the predicted cumulative effects on Vegetation.

Table 12.2.9-3 Cumulative Environmental Effects Summary: Vegetation

Cumulative Environmental Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Current (Baseline) VEC Condition (reflecting the effects of past and ongoing projects and activities)	With the exception of the TLH3, which is followed by a portion of the Project, and the northern (Muskrat Falls) and southern (Strait of Belle Isle communities and infrastructure) segments, the vegetation throughout the LSA remains in a largely natural state. The main habitat types are Open Conifer Forest, Conifer Forests, Conifer Scrub and Wetlands. Wetlands comprise 69 km^2. There are 889 km of Riparian Shoreline habitat (none within PPWSAs) within the LSA. There are no known occurrences of Listed Plants within the LSA, but Fernald's milk-vetch does occur within the RSA; 5% of habitat within the LSA was identified as having High or Very High potential for Regionally Uncommon Plant species. Within the LSA, the majority of Timber Resources occur within the Low Subarctic Forest Ecoregion, with an estimated 706,207 m^3 of merchantable timber.	Vegetation in the LSA in this region remains largely in a natural state, although there has been influence by development (e.g., roads, transmission lines, communities) and timber clearing. The main habitat types are Conifer Forest, Open Conifer Forest and Scrub / Heathland/ Wetland Complex. Wetlands comprise 44 km^2: Approximately, 103 km of riparian habitat in the LSA is within PPWSAs and 975 km is outside. Locations of Listed Plants (e.g., braya species) are known to occur within the LSA, particularly in association with limestone barrens habitats in the area of Flower's Cove; 36% of habitat was identified as having High or Very High potential for Regionally Uncommon Plant species. Timber Resources within the LSA were estimated at 1,689,210 m^3 of merchantable timber.	Vegetation in the LSA in this region has been influenced by development and timber clearing. The main habitat types are Mixedwood Forest (33%) being the most common, followed by Cutover (16%), Open Conifer Forest, Scrub / Heathland / Wetland Complex and Wetlands. In total, Wetlands comprise 76 km^2. For Riparian Shoreline areas, 279 km are within PPWSAs and 771 km outside. There are no known locations of Listed Plants within the LSA. Less than 1% of habitat was identified as having High or Very High potential for Regionally Uncommon Plant species. Timber Resources within the LSA were estimated at 1,910,108 m^3 of merchantable timber.	A concentration of human development (e.g., roads, transmission lines, villages, cottages) occurs within the LSA primarily due to the proximity of population centres. The main habitat types are Scrub / Heathland / Wetland Complex (40%), Mixedwood Forest (20%) and Cutover (10%). Wetlands comprise 21 km^2; 89 km of Riparian Shoreline habitat was identified inside PPWSAs and 549 km outside. Known locations of Listed Plants (e.g., boreal felt lichen) are outside the RSA, notably near Hall's Gullies and Lockyer's Waters in the Avalon Forest Region. Less than 1% of the habitat was identified as having High or Very High potential for Regionally Uncommon Plant species. Timber Resources within the LSA were estimated at 272,806 m^3 of merchantable timber.

Table 12.2.9-3 Cumulative Environmental Effects Summary: Vegetation (continued)

Cumulative Environmental Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Likely Residual Environmental Effects of Labrador - Island Transmission Link (reflecting current VEC condition, as above)	Total area of ROW is 28 km^2, or 4% of the LSA in this region. The centre line ROW intersects no more than 4% of each Habitat Type available within the LSA, 2% (2 km) of Wetland habitat, <1% (<1 km) of Riparian Shoreline habitat within PPWSAs and 3% (27 km) outside of PPWSAs, and less than 2 km^2 or 6% of High or Very High potential habitat for Regionally Uncommon Plants. No loss or alteration to Listed Plants or their habitat is predicted. The loss of Timber Resources is estimated at 25,991 m^3 of merchantable timber.	Total area of ROW is 18 km^2, or 4% of the regional LSA in this region. The centre line ROW intersects no more than 4% of each Habitat Type available within the LSA, 3% (1 km) of Wetland habitat, 10% (10 km) of Riparian Shoreline habitat within PPWSAs and 6% (56 km) outside PPWSAs, and 7 km^2 or 8% of High or Very High potential habitat for Regionally Uncommon Plants. Listed Plants (i.e., Long's braya, Fernald's braya) have been identified as potentially occurring within the ROW and will be avoided to the extent practical. The loss of Timber Resources is estimated to be 65,250 m^3 of merchantable timber.	Total area of ROW plus contingency is 24 km^2, or 4% of the LSA in this region. The centre line ROW intersects a maximum of 8% (i.e., Mixedwood Forest) of Habitat Types available within the LSA, 3% (2 km) of Wetland habitat, 6% (16 km) of Riparian Shoreline habitat within PPWSAs and 7% (53 km) outside PPWSAs, and <1 km^2 or <1% of High or Very High potential habitat for Regionally Uncommon Plants. No loss or alteration to Listed Plants or their habitat is likely. The loss of Timber Resources is estimated to be 71,701 m^3 of merchantable timber.	Total area of ROW is 8 km^2 or 4% of the LSA in this region. The centre line ROW intersects a maximum of 4% of each Habitat Type available within the LSA, 4% of Wetland habitat within the LSA, 5% (5 km) of Riparian Shoreline habitat within PPWSAs and 6% (35 km) outside PPWSAs, and no loss or alteration to High or Very High potential habitat for Regionally Uncommon Plants. No loss or alteration to Listed Plants or their habitat is likely. The loss of Timber Resources is estimated to be 8,490 m^3 of merchantable timber.

Table 12.2.9-3 Cumulative Environmental Effects Summary: Vegetation (continued)

Cumulative Environmental Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	Overlapping projects include: the Lower Churchill Hydroelectric Generation Project, TLH3, commercial forestry activity, general economic and Infrastructure development in the Central Labrador and Labrador Straits region, and other land uses, particularly OHV use. Likely cumulative effects include loss or alteration of habitat as a result of clearing, displacement of native vegetation from the introduction or spread of non-native and invasive species, and disturbance due to increased OHV use.	Overlapping projects include general economic and Infrastructure development, commercial forestry activity, Parsons Pond oil and gas exploration drilling, and other land uses, particularly OHV use. Likely cumulative effects include loss or alteration of habitat as a result of clearing, displacement of native vegetation from the introduction or spread of non-native and invasive species, and disturbance due to increased OHV use.	Overlapping projects include general economic and Infrastructure development, commercial forestry activity, and other land uses, particularly OHV use. Likely cumulative effects include loss or alteration of habitat as a result of clearing, displacement of native vegetation from the introduction or spread of non-native and invasive species, and disturbance due to increased OHV use.	Overlapping projects include general economic and Infrastructure development, commercial forestry activity, and other land uses, particularly OHV use. Likely cumulative effects include loss or alteration of habitat as a result of clearing, displacement of native vegetation from the introduction or spread of non-native and invasive species, and disturbance due to increased OHV use.

Table 12.2.9-3 Cumulative Environmental Effects Summary: Vegetation (continued)

Cumulative Environmental Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Cumulative Environmental Effects Summary	**Not Significant** – At present, access to much of the ROW in this region is restricted to a small number of communities in proximity to the Project and an even smaller number with direct, year round access to the ROW and associated access roads by OHV. Improved public access to and within the area provided by the ROW, and the associated increase in human activity, particularly via OHV in this previously remote area will likely mean an increase in human presence and resource exploitation (e.g., timber). While the contribution of the Project to cumulative environmental effects will likely extend through the life of the Project, they will be limited in scale to the RSA (relative to OHV access) and low in magnitude. Contributing projects have mitigation measures in place to minimize adverse effects and access control measures will be implemented to address increased public OHV use.	**Not Significant** – Density of Listed and Regionally Uncommon Plant species is higher in this region than in any other region. Regulatory consultation has resulted in a particular focus on the limestone barrens in this region. While the contribution of the Project to cumulative environmental effects will likely extend through the life of the Project, they will be limited in scale to the RSA (relative to OHV access) and low in magnitude. Contributing projects have mitigation measures in place to minimize these adverse effects and access control measures will be implemented to address increased public OHV use.	**Not Significant** – This region currently has a higher density of roads, linear developments and past forestry activities. While the contribution of the Project to cumulative environmental effects will likely extend through the life of the Project, they will be limited in scale to the RSA (relative to OHV access) and low in magnitude. Contributing projects have mitigation measures in place to minimize these adverse effects and access control measures will be implemented to address increased public OHV use.	**Not Significant** – This region has the highest human population and thus potentially the highest potential to experience effects from OHV use and resource exploitation. While the contribution of the Project to cumulative environmental effects will likely extend through the life of the Project, they will be limited in scale to the RSA (relative to OHV access) and low in magnitude. Contributing projects have mitigation measures in place to minimize these adverse effects and access control measures will be implemented to address increased public OHV use.

Note: Centre line ROW values include the 20% contingency.

12.2.10 Monitoring and Follow-up

As outlined in *Canadian Environmental Assessment Act*, follow-up is a process designed to verify EA predictions or address issues of uncertainty. All Construction activities will require inspection to ensure that identified mitigation techniques are appropriately applied, maintained, and removed, where necessary. Monitoring programs are those implemented to meet regulatory requirements or demonstrate compliance to commitments made in the EIS. Environmental inspectors (on-site monitors) will be present during Construction to evaluate the success of those measures identified in the EIS (Section 12.2.5), the EPP and that conditions of approval with respect to all required permits are met.

Based on the nature of the Project, compliance with federal and provincial regulatory requirements and concerns raised by the public during the consultation process, Nalcor is proposing to monitor the effects on listed plants or induced effects resulting from improved access. Findings will be incorporated into the environmental management directions to reduce effects during Project phases (i.e., adaptive management). Integral to this will be a follow-up program targeting known locations of listed plant species and their important habitats, coupled with a review of OHV use facilitated by the Project. Nalcor will consult with Environment Canada and the NLDEC Wildlife Division regarding the design of such a program. In the growing season following Construction, known locations of listed plant species identified within, or adjacent to the Project components will be revisited to evaluate the health and extent of the population. This will include evaluating the success of mitigation efforts undertaken to protect Listed Plants during Construction. The information collected will be used to develop mitigation, in consultation with vegetation experts, as appropriate, through Nalcor's adaptive management program.

The ROW and other Project components (e.g., access) will be routinely inspected throughout the life of the Project. During these inspections, conducted either from the ground or the air, the inspectors will note any areas of environmental concern related to Vegetation within or adjacent to the Project components, including: bare soil or delayed regeneration (including reclamation success); erosion (including effectiveness of erosion control in relation to steep slopes, river crossings and wetlands); siltation of waterbodies, wetlands and / or rivers; introduction or spread of non-native and invasive species; and unauthorized access and resulting disturbance. Areas of disturbance will be noted and the appropriate reclamation strategy designed and implemented in a timely manner.

12.3 Caribou

12.3.1 Introduction

Caribou have been identified as a VEC because of their occurrence throughout the province, their role in the ecosystem, their economic and cultural importance and because several herds in Labrador are of special conservation concern and protected under both provincial and federal legislation. Considered in this assessment are sedentary woodland caribou near the Project throughout Newfoundland and Labrador. Sedentary woodland caribou are a forest-dwelling ecotype that undergoes a seasonal dispersion (rather than migration) during calving (Bergerud et al. 2008). Woodland caribou are native to Newfoundland and Labrador, are part of the Boreal population, and belong to the sedentary (forest-dwelling) ecotype (NLDEC 2009a, internet site), although some herds in Newfoundland traditionally exhibit behaviour similar to migratory caribou herds (Dyke 2010, pers. comm.).

In Labrador, the ranges of two sedentary herds overlap the Study Area and are therefore included in this assessment: the Red Wine Mountains Herd (RWMH) and Mealy Mountains Herd (MMH). Both herds are listed as threatened under the *NLESA* and *SARA.* These herds were more abundant in the 1960s, before increased access was available (Bergerud et al. 2008). Since then, these herds have declined, possibly from hunting availing of increased transportation networks and snowmobiles (Bergerud et al. 2008). The approximate density of sedentary caribou in Labrador is three caribou per 100 km^2 (NLDEC 2009a, internet site). The NLDEC have recently identified the range of an additional group of caribou, referred to as the Joir River caribou, described as a subpopulation of the MMH (Blake 2011a, pers. comm.; Blake 2011b, pers. comm.). Except where specified, discussion of the MMH includes the Joir River caribou. Other sedentary herds of caribou in Labrador that do not overlap the Study Area have not been carried forward in this assessment.

Also in Labrador is the George River Herd (GRH), a migratory ecotype of caribou (Section 10.3.4), that ranges to the north of the transmission corridor and Study Area. Historically, the GRH used the Study Area inconsistently, only wintering there in certain years. More recently, the GRH has wintered west of the northern end of the Study Area in Central and Southeastern Labrador. Since the Study Area receives inconsistent seasonal use by this herd, any use of the area is likely to be by individuals or small groups rather than thousands of caribou. Due to the limited nature of any likely Project interaction with the GRH, it has not been carried forward in this assessment.

Woodland caribou in Newfoundland are also considered sedentary; however, in contrast to those in Labrador they are not listed as threatened (NLDEC 2009a, internet site). Historically, caribou were abundant in Newfoundland in the early 1900s, but declined rapidly between 1915 and 1930 (NLDEC 2009a, internet site). The population remained relatively low in numbers until the 1970s; then, their abundance increased to approximately 90,000 caribou in the late 1990s (NLDEC 2009a, internet site). Since the late 1990s, their abundance has again declined to an estimated 34,000 caribou (Lewis et al. 2011), representing a density of approximately 30 caribou per 100 km^2 (NLDEC 2009a, internet site).

There has been a recent shift in the understanding of caribou herds in Newfoundland. The NLDEC Wildlife Division has adopted and is advocating a more "ecoregional" approach that describes caribou as occurring throughout Newfoundland in various densities rather than the traditional “herd” approach (Dyke 2010, pers. comm.). Aside from the delineation of Caribou Management Areas for harvest management purposes, where traditional herd names are still used, provincial researchers are discussing the idea of a caribou metapopulation in Newfoundland (Dyke 2010, pers. comm.; Saunders 2010, pers. comm.). Results of recent genetic analysis have suggested that except for the herds on the Avalon Peninsula, there is a lack of genetic differention among both herds and regions, which suggests a large amount of genetic exchange, or mixing, among most herds in Newfoundland (Wilkerson 2010). There is a haplotype present in the St. Anthony herd that is also present in several central herds, but absent from the Northern Peninsula herd, which is located in between the St. Anthony and Central herds (Wilkerson 2010). Additionally, the haplotypes present in the Avalon and Cape Shore herds are distinct from the rest of the Island herds (Wilkerson 2010).

Caribou were selected over other ungulate species (e.g., moose), and addressed as a VEC and not a KI, primarily due to their status, their sensitivity and the ongoing attention to their sustainability within the province. Moose were not selected as a KI primarily because they are not native (i.e., they are an introduced species), and determining the effects of the Project on their population and distribution is not practical, especially with recent provincial government initiatives to reduce moose-vehicle collisions (see Section 10.3.5.3), and would not meaningfully inform the assessment. The number of mortalities predicted to be directly and indirectly attributable to the Project as it relates to increased moose habitat and the increased predation is assessed as an MP.

12.3.2 Environmental Assessment Study Areas

12.3.2.1 Spatial Boundaries

The LSA is where the Project-related components and activities that will likely affect Caribou occur. The LSA therefore includes the 2 km wide transmission corridor while also considering the general nature and location of other Project activities and components (e.g., access, electrode lines, camps, storage areas), where these overlap with areas of Caribou occupancy (Figure 12.3.2-1 and 12.3.2-2).

The RSA differs between Labrador and Newfoundland. The NLDEC Wildlife Division provided Nalcor with recently revised distribution data for Caribou in the province. In Labrador, the RSA is defined by the boundaries of recognized Caribou herd ranges that intersect with the LSA. The RSA in Labrador therefore corresponds with the ranges of the RWMH and MMH (Figure 12.3.2-1). In Newfoundland, where Caribou distribution is described in terms of occupancy areas, the RSA is defined as the total Occupancy Area (Figure 12.3.2-2).

FIGURE 12.3.2-1

Local and Regional Study Areas for Caribou, Labrador

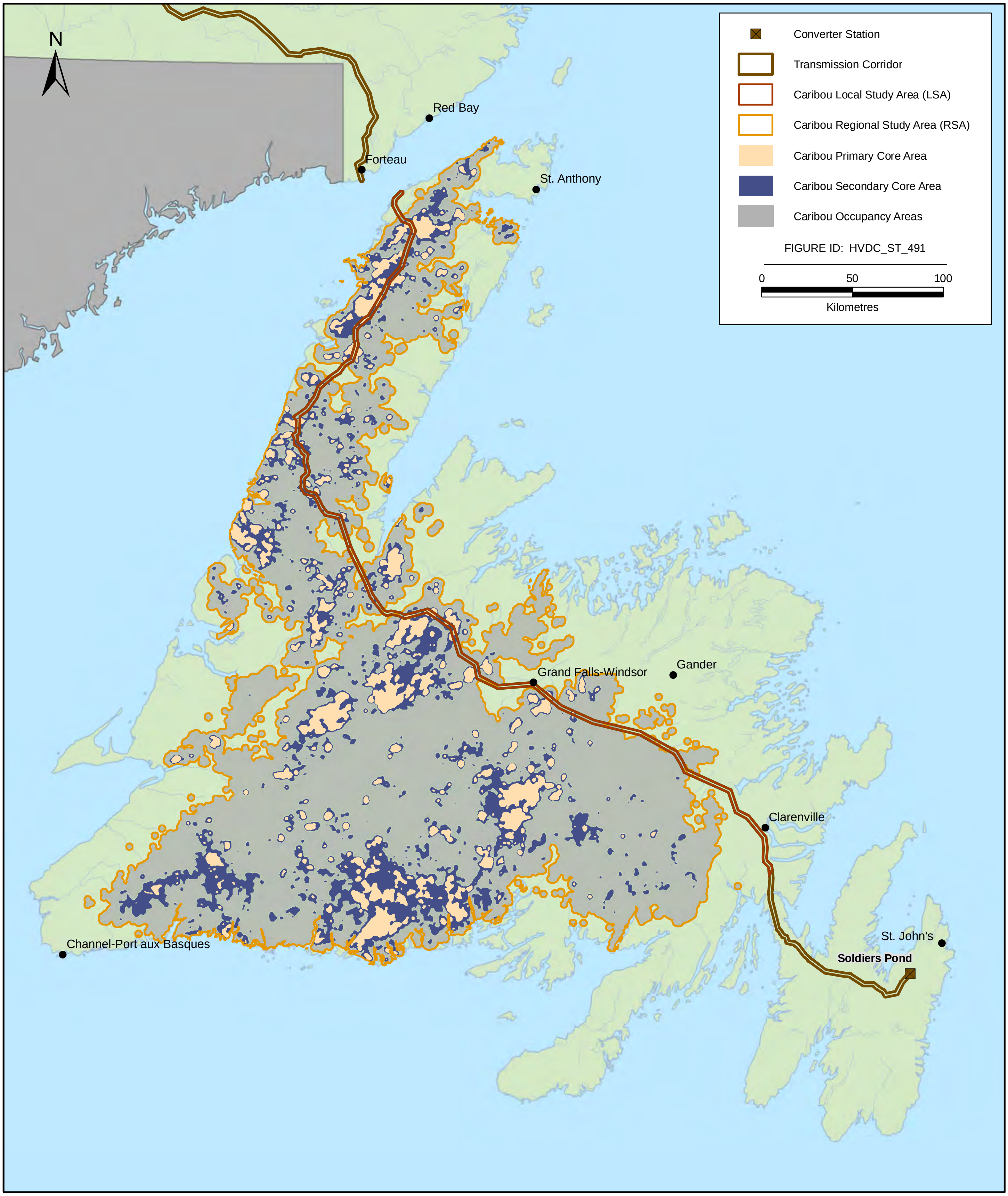


FIGURE 12.3.2-2

Local and Regional Study Areas for Caribou, Newfoundland

12.3.2.2 Temporal Boundaries

Temporal boundaries for the effects assessment are the Construction phase (approximately 4 years from start to finish along the corridor's length) and the Operations and Maintenance phase that is assumed to occur in perpetuity. Sedentary woodland Caribou often display some seasonal movement between different parts of their range. Therefore, depending of the time of year, caribou may be residing within the LSA or RSA or moving through while travelling to other seasonal range.

12.3.3 Potential Environmental Issues, Indicators and Interactions

12.3.3.1 Potential Environmental Issues

The potential environmental issues identified in Table 12.3.3-1 reflect consultation with stakeholders and regulators, including the NLDEC Wildlife Division, and those issues considered in previous assessments for Caribou.

Table 12.3.3-1 Identified Issues and Questions: Caribou

Issue / Question	Nature and Rationale	Specific Considerations
Alteration or loss of habitat (including as a result of sensory disturbance)	– May influence abundance, distribution, productivity of Caribou	– If habitat is limiting or 'core' habitat is affected, habitat loss could conflict with management objectives for recovery – Of particular concern for the two herds of special conservation status in Labrador
Increased access	– May increase mortality due to hunting (legal and illegal), as well as predation	– Identified by the NLDEC Wildlife Division (March 17, 2010 meeting) as a particular challenge where hunting and / or predation has been identified as a causal factor in population decline – Of particular concern for the two herds of special conservation status in Labrador
Increase in habitat for moose	– May increase moose and predator populations; increased predator populations may lead to an increase in Caribou mortality due to predation	– Predation and altered predator-prey interactions have been identified as contributors to the decline of Caribou populations
Direct Project mortality	– Accidental loss of animals through vehicle collisions, or other interaction with Project activities	– Concern would be greatest during Construction when Project traffic is at its peak and during winter when individuals may occur between high snow banks along the sides of the roads

12.3.3.2 Key Indicators and Measurable Parameters

Three KIs were selected as relevant to or reflective of the potential effects of the Project on caribou: the two woodland Caribou herds that will interact with the Project in Labrador, namely the RWMH and MMH, and Caribou that will interact with the Project in Newfoundland. Rationale for the selection of these KIs is provided in Table 12.3.3-2. As shown in Table 12.3.3-2, MPs for each KI were identified to determine the amount of habitat altered or lost, and changes in abundance through direct, indirect, or induced mortality resulting from Project-related effects.

Table 12.3.3-2 Key Indicators and Associated Measurable Parameters: Caribou

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Central and Southeastern Labrador Caribou (includes RWMH and MMH)	– Currently listed as threatened under *NLESA* and *SARA* – RWMH population estimated at 97 in 2001 – Southeastern portion of the RWMH caribou range overlaps with the northern portion of the LSA in Labrador – Western portion of the MMH range overlaps with the central portion of the LSA in Labrador – The role Caribou play in the ecosystem – Caribou have cultural importance for Aboriginal groups and other local stakeholders	– Amount of range that is predicted to be lost due to the Project relative to its availability in the RSA – Amount of primary habitat (km^2) within the range that overlaps with the assessment area relative to its availability in the RSA – Amount of primary habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the RSA	– Regulators have identified primary or core habitat in recovery plans for management purposes – Reducing, altering or fragmenting primary habitat could affect the population
		– Number of mortalities predicted to be directly and indirectly attributable to the Project	– Vehicle-caribou collisions or other direct interactions with the Project and related activities may occur – Indirect mortality events may occur (e.g., due to increased predation and illegal hunting pressure)
Newfoundland Caribou	– Caribou distribution in Newfoundland intersects the LSA – The role Caribou play in the ecosystem – Caribou have cultural and economic importance for local stakeholders	– Amount of Primary Core area[a] that may be affected by the Project relative to its availability in the RSA – Amount of occupied primary habitat (km^2) that overlaps with the assessment area relative to its availability in the RSA – Amount of primary habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the RSA	– Reducing, altering or fragmenting primary habitat could affect the population
		– Number of mortalities predicted to be directly and indirectly attributable to the Project	– Vehicle-caribou collisions or other direct interactions with the Project and related activities may occur – Indirect mortality events may occur (e.g., due to increased predation and illegal hunting pressure)

(a) Refer to Section 10.3.4.3 for an explanation of Primary Core areas, Secondary Core areas, and Occupancy Areas. These areas are defined based on the probability of woodland caribou occurrence within the area, i.e., 50%, 80% and 100%, respectively.

12.3.3.3 Potential Project-Caribou Interactions

A number of Project activities can potentially affect Caribou. The clearing of vegetation will directly remove habitat for woodland caribou. As woodland Caribou are known to avoid disturbances by several kilometres, many of the Project activities will be perceived by Caribou as disturbances to be avoided. The Project activities that will directly contribute to sensory disturbance and resulting avoidance of the area by Caribou include vegetation clearing within the ROW, presence of humans, and construction noise and dust. Construction activity will proceed from multiple points along the ROW simultaneously. Since the LSA has been identified as overlapping with the range or Primary Core area of the selected KIs, the Project will result in habitat alteration or loss and potential fragmentation.

There are a number of potential indirect effects from the Project. Construction of access roads and the ROW could result in increased public access and use of the area by off-highway vehicles (OHVs). This has the potential to increase sensory disturbance effects associated with the Project. Increased access may also facilitate the movement of hunters and predators into caribou habitat, which could result in increased Caribou mortality (James and Stuart-Smith 2000, Stuart-Smith et al. 1997). The creation of early-seral vegetation communities through clearing may result in increased moose populations and subsequent increases in predator populations, which may also lead to increased Caribou mortality (Latham et al. 2011). Potential increases in mortality are of concern for declining populations that are particularly vulnerable, such as those that have been afforded protection under the *NLESA* and *SARA.*

Potential effects related to increased access will continue during the Operations and Maintenance phase. Activities associated with the Project during this phase include routine line inspection, repairs as required, and vegetation management along the ROW. Habitat may be altered as a result of mechanical and chemical vegetation management activities (e.g., to control vegetation height and the spread of invasive and non-native species). Vegetation management will commence approximately eight years after Construction is complete, and occur every seven years thereafter during Operations and Maintenance. Sensory disturbance during maintenance and inspection activities would be expected to result in temporary avoidance of the area by Caribou at site-specific locations.

Interactions of Project activities and physical works with the KIs will determine the scope of the assessment. The specific number, location and characteristics of all Construction activities, will be determined as part of ongoing Project engineering and design. Table 12.3.3-3 identifies the potential Project interactions with each KI for the Caribou VEC and provides a brief summary of the rationale for their selection.

Table 12.3.3-3 Potential Project Interactions: Caribou

Project Phase / Activity	Key Indicators	
	Central and Southeastern Labrador Caribou	Newfoundland Caribou
Construction		
Construction access trails and roads	– Habitat alteration or loss – Increased access and indirect mortality (through increased predation and hunting) – Changes to migration or movement routes and / or timing of travel	– Habitat alteration or loss – Increased access and indirect mortality (through increased predation and hunting) – Changes to migration or movement routes and / or timing of travel
Movement and presence of personnel, equipment and materials	– Sensory disturbance – Direct mortality	– Sensory disturbance – Direct mortality
Construction camps	– Habitat alteration or loss – Sensory disturbance	– Habitat alteration or loss – Sensory disturbance

Table 12.3.3-3 Potential Project Interactions: Caribou (continued)

Project Phase / Activity	Key Indicators	
	Central and Southeastern Labrador Caribou	**Newfoundland Caribou**
Marshalling yards and staging areas	– Habitat alteration or loss – Sensory disturbance	– Habitat alteration or loss – Sensory disturbance
Right of way clearing and preparation	– Habitat alteration or loss – Sensory disturbance – Increased access and indirect mortality (through increased predation and hunting) – Changes to migration or movement routes and / or timing of travel	– Habitat alteration or loss – Sensory disturbance – Increased access and indirect mortality (through increased predation and hunting) – Changes to migration or movement routes and / or timing of travel
Quarrying and borrowing	– Habitat alteration or loss – Sensory disturbance	– Habitat alteration or loss – Sensory disturbance
Transmission tower assembly and installation	– Habitat alteration or loss – Sensory disturbance	– Habitat alteration or loss – Sensory disturbance
Conductor installation	– Habitat alteration or loss – Sensory disturbance	– Habitat alteration or loss – Sensory disturbance
Converter station site preparation and construction	– Habitat alteration or loss – Sensory disturbance	– Habitat alteration or loss – Sensory disturbance
Preparation and construction of submarine cable landing sites (on-land works)	—	—
Construction and installation of submarine cables (Marine works)	—	—
Electrode site preparation and installation	– No overlap with caribou ranges at electrode site	– No overlap with caribou occupancy areas at electrode site
Island system upgrades		
Employment / presence of workers	—	—
Contracting / expenditures	—	—
System commissioning	—	—
Operations and Maintenance		
Access trails and roads	– Habitat alteration or loss – Sensory disturbance – Increased access and indirect mortality (through increased predation and hunting)	– Habitat alteration or loss – Sensory disturbance – Increased access and indirect mortality (through increased predation and hunting)
Presence and operation of the transmission system	– Habitat alteration or loss – Sensory disturbance – Increased access and indirect mortality (through increased predation and hunting)	– Habitat alteration or loss – Sensory disturbance – Increased access and indirect mortality (through increased predation and hunting)
Routine line inspections and repairs	– Sensory disturbance	– Sensory disturbance

Table 12.3.3-3 Potential Project Interactions: Caribou (continued)

Project Phase / Activity	Key Indicators	
	Central and Southeastern Labrador Caribou	**Newfoundland Caribou**
Vegetation management	– Habitat alteration or loss – Sensory disturbance	– Habitat alteration or loss – Sensory disturbance
Potential major system repairs	– Sensory disturbance	– Sensory disturbance
Operation of the electrodes	—	—
Employment / presence of workers	—	—
Contracting / expenditures	—	—

— No likely or detectable interaction identified.

12.3.4 Approach to the Environmental Effects Analysis

12.3.4.1 Analytical Methods

Baseline conditions were characterized for Caribou based on studies conducted over the last 20 years by various authors throughout the province, as presented in the *Caribou and Their Predators Component Study* (Stantec 2012a, 2011d). This includes current baseline conditions, habitat association and distribution of Caribou along the LSA and potential limiting factors. A key source of information was the extensive research compiled by the NLDEC Wildlife Division. Aerial surveys, radio and satellite telemetry collaring and other research have been used by the Wildlife Division to describe existing conditions for this species and assist with management.

For Construction, the main issue for Caribou is the potential alteration and / or loss of habitat due to vegetation clearing and associated disturbance. The amount of habitat loss resulting from the Project due to clearing activities was assessed based on the hypothetical 60 m wide ROW located along the centre line of the transmission corridor, plus a 20% contingency applied as a precautionary approach to inform the assessment. As described in Section 12.2.4.1 under the Vegetation VEC, this contingency, also used in other VEC analyses, accounts for the anticipated alignment and access trail deviations from the hypothetical ROW and the 32 km of access road (20 km in Labrador and 12 km in Newfoundland) which will be constructed outside the final ROW alignment. In Labrador the assessment considers the amount of affected Caribou range (area (km^2) and proportion of range). In Newfoundland the amount of affected occupancy areas (area (km^2) and proportion of Primary Core area, Secondary Core area and Occupancy area (as defined in Section 10.3.4.3)) are assessed.

The amount of Caribou habitat that may be affected by sensory disturbance due to the Project during Construction was assessed by placing a 500 m buffer on each side of the LSA (i.e., assessment area = 3 km total width) and quantifying the amount of primary ranked habitat (from ELC) and Caribou range (for Labrador) or occupancy areas (for Newfoundland) within that area. As the final ROW alignment could occur anywhere within the 2 km transmission corridor, a buffer width of 500 m was selected based on research regarding avoidance of roads by Caribou (Table 12.3.4-1; Dyer et al. 2001). Although Dyer et al. (2001) found that open habitat beyond 250 m from roads was not significantly avoided a 500 m buffer was selected to express the apparent avoidance observed, as well as to provide a conservative assessment of Project effects. This approach is consistent with the proposed Environment Canada (2011b) Recovery Strategy for Woodland Caribou, Boreal Population, which defines 'undisturbed habitat' as that beyond 500 m from disturbances. As there is no expected avoidance of roads beyond 500 m of the disturbance (Dyer et al. 2001), and much of the LSA will remain undisturbed by the Project, not all habitat within the 3 km construction assessment area will be affected. Of the habitat that is affected, the amount of alteration will depend on the type of activity and proximity to the disturbance.

Table 12.3.4-1 Mean Woodland Caribou Use of Habitat within Zones of Influence Surrounding Industrial Developments

Type of Development	Zone of Influence (m)	Effectiveness of Habitat Use (Percentage of Expected Use)
Roads	0 to 100[(a)]	3.65 (late winter) to 33.93 (summer)
	100 to 250[(a)]	22.7 (summer) to 25.18 (calving)
	250 to 500	31.55 (summer) to 57.52 (calving)

Source: Dyer et al. 2001.
(a) Avoidance was significant relative to locations >3,000 m from a given development type.

The effects assessment considers the nature and degree of Project-induced changes from baseline conditions, following implementation of standard mitigation practices by Nalcor.

Caribou Distribution in Labrador

A series of detailed habitat quality maps were generated for herds whose known ranges overlap the Project within each season (i.e., winter and calving / post-calving), indicating the distribution and abundance of primary, secondary and tertiary habitat within the LSA. Primary habitat was defined as that providing foraging, protection from predation (or other potential limiting factors) and resting habitat. Secondary habitat provides an abundance of one or two of the three elements, or marginal amounts of all three elements. Tertiary habitat provides marginal foraging, protection or resting opportunities or may only be used during transit.

The range of herds in Labrador has been documented based on information provided by the NLDEC Wildlife Division. Caribou ranges were expressed as minimum convex polygons (MCPs), based on telemetry data from collared caribou, which do not reflect seasonal or annual intensity of range use, or movements by individuals to adjacent herds (Blake 2011a, pers. comm.). Furthermore, Caribou may occur beyond the MCP boundaries or the MCP may include areas not used by Caribou. The focus of the assessment was to identify the quality of habitat that overlaps both areas. This quantification is based on the exercise conducted in the *Caribou and Their Predators Component Study* (Stantec 2012a, 2011d), whereby Habitat Types identified and quantified within the transmission corridor as part of the Project ELC (Stantec 2011a; Stantec 2010b) were classified as primary, secondary or tertiary habitat for Caribou. The assessment quantified the amount (by area (km^2) and proportion) of Caribou range within the LSA and RSA and determined the changes due to direct and indirect effects.

Caribou Distribution in Newfoundland

Caribou occur across Newfoundland in varying densities, and, as there appears to be a great deal of movement between formerly recognized herds, some researchers are considering caribou in Newfoundland a metapopulation (Dyke 2010, pers. comm.; Saunders 2010, pers. comm.). The NLDEC currently describes caribou distribution in Newfoundland based on levels of usage determined from telemetry data from collared caribou. As explained in Section 12.3.2, Habitat Types were identified and quantified, and detailed habitat maps were generated for areas where the Project ELC overlaps Caribou occupancy areas (Primary Core area – 50% kernel; Secondary Core area – 80% kernel; Occupancy Area – 100% kernel) provided by NLDEC Wildlife Division (Blake 2011a, pers. comm.). The assessment calculated the amount and proportion of each of these areas potentially affected by activities in the LSA and RSA by quantifying the amount (by area (km^2) and proportion) of Caribou occupancy areas within the LSA and RSA and determining the changes due to direct and indirect effects. Habitat quality was also determined for the occupancy areas that overlap with the LSA in Newfoundland.

Environmental Effects Descriptors

Environmental effects of the Project on each KI were described using five attributes: direction; magnitude; geographic extent; duration; and frequency. While frequency is not defined in Table 12.3.4-2, it is used to further describe the likely Project effects on KIs. Values are consistent with other environmental assessments in the province (e.g., Nalcor 2009).

Table 12.3.4-2 Effects Descriptors: Caribou

Effects Descriptor	Definition
Direction[a]	
Adverse	– Habitat loss or alteration – Direct or indirect mortality through vehicle collisions or increased hunting / predation – Reduced forage availability or access – Changes in migration or movement routes
Neutral	– No increase or decrease in population size, habitat, forage availability
Beneficial	– Increased foraging opportunities – Enhancement of habitat
Magnitude[b]	
No effect	– No potential effect on KI
Low	– <5% of the range (Labrador) or Primary Core area (Newfoundland) will be exposed to the effect – Predicted to have no measurable change to Caribou populations
Moderate	– 5% to 25% of the range (Labrador) or Primary Core area (Newfoundland) will be exposed to the effect – Predicted to have a measurable change in Caribou populations relative to baseline conditions that does not cause management concern
High	– >25% of the range (Labrador) or Primary Core area (Newfoundland) will be exposed to the effect – Predicted to have a measurable change in Caribou populations relative to baseline conditions that does cause management concern
Geographic Extent[c]	
Local	– Environmental effects confined to the LSA
Regional	– Environmental effects confined to the RSA
Beyond regional	– Environmental effects extend beyond the RSA
Duration	
Short-term	– Effect will be evident for less than one year
Medium-term	– Effect will be evident for between one and four years (Construction period)
Long-term	– Effect will be evident for longer than four years, but does not extend more than 30 years
Far future	– Effect will be evident throughout Project Operations and Maintenance

[a] Degree of change from baseline condition.
[b] Nalcor 2009; Vale Inco Newfoundland and Labrador Limited 2008; Newfoundland and Labrador Refining Corporation 2007.
[c] Spatial area within which an effect may occur.

12.3.5 Construction

12.3.5.1 Overview of Project Construction and Associated Effects Management

Construction involves clearing of vegetation for access roads, trails, construction camps, marshalling yards, and staging areas, followed by quarrying and borrowing to obtain parent material. Noise, vibration, lights, and general activity along the ROW will be present during clearing and installation. Caribou are sensitive to habitat loss, fragmentation and disturbance that will occur with the clearing of the ROW, road alignments and associated Project components.

Caribou in the boreal forest require large tracts of relatively undisturbed, older forest habitat to spread out so they are harder for predators and hunters to locate, and to avoid the linear corridors used by predators and hunters. Alteration of habitat, specifically the creation of early successional, shrubby habitat that may occur as a result of forest clearing, may also lead to an increase in moose numbers resulting in increased predation pressure (Fortin et al. 2008; Mahoney and Virgil 2003).

Indirect mortality is also possible as a result of increased access to previously remote areas. This is a particular concern for sedentary Labrador Caribou herds listed under *SARA* and the *NLESA*. Both the RWMH and the MMH have experienced illegal hunting activities, and increased access could contribute to this existing problem.

Movement and presence of personnel, equipment and materials during Construction may result in disturbance and displacement of Caribou. Transmission tower assembly and tower and conductor installation will present localized disturbance, but transporting materials on-site will be more disruptive as construction progresses along the ROW, as helicopters and large tracked vehicles may be used to bring in larger components. There is also a possibility of direct mortality or injury due to collisions with Project-related vehicles.

Converter station site preparation and construction could have an effect on Caribou in Labrador. However, the Newfoundland converter station is to be installed on the Avalon Peninsula, where Caribou do not overlap with the LSA. Construction of submarine cable landing sites and marine works will have no effects on Caribou, as these locations are not within areas occupied by this species. Electrode sites proposed for L'Anse au Diable and Dowden's Point are also outside areas of Caribou habitat or known distribution and will not have any interaction with the KIs.

Nalcor is proposing mitigation measures to reduce the potential effect of habitat alteration or loss / fragmentation, including using existing disturbed areas as much as possible, limiting the number of access roads and decommissioning these roads following Construction wherever practical. Nalcor will use the data on Caribou core areas provided by the NLDEC Wildlife Branch during final ROW alignment selection to avoid Primary Core areas, to the extent feasible. In Labrador, the 20 km long access road will be constructed outside of caribou range. The 12 km long access road at the base of the Northern Peninsula (alignment unknown) will be constructed within Caribou habitat, but will be routed to avoid Primary Core area by a minimum of 500 m to the extent practical. Limitations to vegetation removal will also reduce opportunities for direct and indirect mortality of Caribou. Therefore, the mitigation measures identified for the Vegetation VEC in Section 12.2.5 are also considered appropriate for limiting effects on Caribou. In addition, mitigation identified in Section 11.2.5 to minimize dust and noise associated with Project Construction is also considered applicable to this VEC. Mitigation measures relevant to vegetation, noise and dust, as well as additional mitigation measures employed by Nalcor for transmission line construction elsewhere in the province and applicable to Caribou include:

- Nalcor will use the data on Caribou core areas provided by the NLDEC Wildlife Division during final ROW alignment selection to avoid Primary Core area, to the extent feasible.
- New access roads will, to the extent practical, be routed to avoid Primary Core areas of Newfoundland Caribou by at least 500 m.
- Vegetation removal will be limited to reduce opportunities for direct and indirect mortality of Caribou such as:
    - clearing activities will only occur within the ROW and other site specific areas (e.g., converter station, marshalling yards, camps).

- Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures:
  - all vegetation shall be cut within 150 mm of the surface of the ground;
  - all vegetation that exceeds 2 m height at maturity will be cut;
  - trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed; and
  - merchantable timber will be cleared through various means (e.g., feller-buncher (mechanical), hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m.
- Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats.
- A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.
- Mobile storage tanks will comply with the transportation of Dangerous Goods regulation SOR/200834, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the Environmental Protection Act.
- Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel.
- Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response.
- Existing access roads will be used and development of new access will be minimized, to the extent practical.
- Nalcor will comply with laws and regulations pertaining to fish and wildlife, forest fires, forest travel, smoking and littering.
- Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic.
- Well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed.
- During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.
- Haul distances for construction material will be limited to the extent practical.
- Construction activities will be conducted in accordance with municipal by-laws regarding noise.
- High noise-producing construction equipment will be strategically placed as far away as practical from receptors.
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.

- The size of explosive charges will be limited during blasting activities. Three hours prior to any blasting, a visual reconnaissance of the area will be conducted to establish the presence of any wildlife; blasting will be delayed where practical until wildlife have been allowed to leave the area of their own accord.
- Work activities will occur in a manner that does not deliberately harass wildlife.
- Only essential vehicular activity, including helicopter flights, will be permitted within the transmission corridor to minimize disturbance to wildlife.
- Project personnel will adhere to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions.
- Signage will be installed to indicate crossing areas in known Caribou crossing areas.
- Active work areas and access roads will be off limits to unescorted non-Project personnel, including during hunting season.
- Project personnel will not be permitted to possess firearms or have pets on-site and Nalcor will enforce a 'no-harvesting' policy during working hours. The exception to firearm possession will be bear monitors as described in the EPP.
- Site-specific mitigation measures relating to Caribou will also be developed as practical prior to and during the Construction phase in consultation with NLDEC. Project activities and access to facilities will be controlled, limiting disturbance when individual Caribou are present. In Labrador, Nalcor will also continue its participation on the Labrador Woodland Caribou Recovery Team (LWCRT) and support of related research, such as the telemetry monitoring program. Additional mitigation will include limiting activity in Primary Core area of Newfoundland Caribou during the sensitive calving / post-calving season, as feasible.

12.3.5.2 Existing Knowledge

Table 12.3.5-1 summarizes the scientific and government literature regarding the effects of the construction of similar projects on Caribou. As identified previously, key issues associated with Construction include loss or alteration of habitat due to clearing and sensory disturbance from Construction activities. While the existing sources of knowledge are not all specifically related to construction of transmission lines, they are relevant in understanding issues related to effects on caribou resulting from construction type activities and linear disturbances. Other sources presented in Table 12.3.5-1 relate to the potential effects of increased access leading to indirect mortality, particularly with respect to Caribou herds in Labrador.

Table 12.3.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Caribou

Reference	Study / Project Context	Summary of Findings
Bergerud et al. (2008)	The return of caribou to Ungava	– Increased access to sedentary caribou ranges, via development projects and the introduction and availability of snowmobiles, has contributed to the observed increase in hunting pressure
Fortin et al. (2008)	Winter selection of landscapes by woodland caribou: behavioural response to geographical gradients in habitat attributes	– Woodland caribou avoid early successional forests, including recently burned and harvested forests – In winter, areas supporting alternative prey tend to be avoided as they may increase the risk of predation by wolves
Courtois et al. (2007)	Effects of forest disturbance on density, space use, and mortality of woodland caribou	– Reported that multi-year and annual home ranges of woodland caribou in Quebec increased in size with landscape disturbance (up to 40% disturbance), while home range fidelity decreased – May indicate that individuals were trying to remain dispersed over a broad area, rather than be confined to a smaller area within the development landscape – Limited data showed higher predation within the disturbed landscapes
Morgan and Doucet (2007)	Forest Management Guidelines for Woodland Caribou (*Rangifer tarandus* caribou) for the Island of Newfoundland	– Provides recommendations for forest management guidelines when working within or near woodland caribou core calving and wintering areas – Includes identification of 10 km buffers of woodland caribou core areas and migration corridors
Schaefer and Mahoney (2007)	Effects of progressive clearcut logging on Newfoundland Caribou	– In Newfoundland, female caribou showed avoidance of cutovers during cut block layout and logging, while males did not show avoidance or selection – Avoidance may be driven by increased human disturbance, increased predation risk to females and calves, as well as reduced availability of forage following clearing
Vors et al. (2007)	Woodland caribou extirpation and anthropogenic landscape disturbance in Ontario	– Reported absence of caribou within 13 km of cutovers in Ontario; this distance increased to 50 km near cutovers greater than 20 years old – Historical analyses on caribou range in Ontario identified a two-decade lag between clear-cutting and extirpation that may reflect the time required for moose and wolf to colonize harvested areas following habitat change
Burzynski et al. (2005)	State of the Park Report, Gros Morne National Park of Canada: An Assessment of Ecological Integrity	– Adjacent land-uses have increased forest access roads along the Park's eastern boundary, increasing access to the Gros Morne Herd – Increased recreational use of snowmobiles in Gros Morne National Park and the interaction between Park users and caribou is a concern for Park managers. The development of management strategies for both residents and commercial groups will aim to maintain ecological integrity

Table 12.3.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Caribou (continued)

Reference	Study / Project Context	Summary of Findings
Schmelzer et al. (2004)	Recovery Strategy for three Woodland caribou herds (*Rangifer tarandus* caribou; Boreal population) in Labrador, Canada	– Limiting factors and potential threats include predation, poaching (both RWMH and MMH) and possible emigration to the GRH (RWMH only). During 2003, poaching accounted for the loss of at least 14 animals, or 15% of the RWMH. – Future increases in industrial development, commercial forestry and road development may affect caribou, through direct or indirect habitat loss, alteration of movement patterns and dispersion of individuals between herds and / or direct mortality of individuals (e.g., poaching, vehicle collisions). – Small size of the RWMH, continued high adult female mortality, and potential habitat loss within its range, threaten recovery of the herd – Minimum viable population size analyses for sedentary caribou herds have not been completed.
Harron (2003)	Effects of transmission lines and other linear developments on wildlife in Manitoba, Working Draft	– For wolves, transmission lines result mostly in direct mortality through hunting or trapping and some vehicle collisions; also result in enhanced travel opportunities unless also used by hunters, in which case the ROW is abandoned by wolves. – Wolf densities and ungulate kill sites are higher in areas of lower road density. – Linear features act as travel corridors for wolves, with average travel speeds almost three times faster than travel speeds in forest.
Dyer et al. (2002)	Quantifying barrier effects of roads and seismic lines on movements of female woodland caribou in northeastern Alberta	– Seismic lines were not barriers to caribou movements, whereas roads with moderate vehicle traffic acted as semi-permeable barriers to caribou movements. The greatest barrier effects were evident during late winter, when caribou crossed actual roads six times less frequently than simulated road networks. – The occurrence of a high density of linear features or other disturbances on a landscape may reduce the ability of caribou to move throughout its home range and compromise its ability to disperse across the landscape at low densities; this may crowd individuals into smaller areas and possibly increase vulnerability to predation.
Mahoney and Schaefer (2002)	Hydroelectric development and the disruption of migration in caribou	– The Star Lake Hydroelectric development was shown to alter migration patterns and result in spatial avoidance both during construction and following development. – Determined that the year-to-year consistency of fall and spring migration among individuals was apparent before and after construction, but not during construction. – Caribou were less likely to occur within 3 km of the Star Lake Hydroelectric development during construction and up to two years post-construction. – Concludes that the development caused a disruption of migrational timing during construction and diminished use of the range surrounding the project site over the longer-term.

Table 12.3.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Caribou (continued)

Reference	Study / Project Context	Summary of Findings
Thomas and Gray (2002, internet site)	Update COSEWIC status report on the woodland caribou *Rangifer tarandus caribou* in Canada	– Percent frequency of concerns relative to threats of local caribou herds within Newfoundland are: access and disturbance (82%); predation (74%); forestry and other developments (56%); fire (41%); and available habitat (29%).
Dyer et al. (2001)	Avoidance of industrial development by woodland caribou	– Sensory disturbance may be less of an issue compared to the functional loss of habitat due to avoidance of development and human activity. – Because of the sensitivity of caribou, especially females, to disturbance, and avoidance of development areas (as discussed above), industrial activity could force individuals to crowd or concentrate at higher densities in undisturbed areas, potentially increasing predation risk. – Linear corridors may provide access for wolves into otherwise inaccessible habitat, such as wetland and bog habitats that act as refugia for caribou, resulting in increased predation.
Schaefer et al. (1999)	Demography of decline of the Red Wine Mountains caribou herd	– Between the 1980s and 1990s, three mortalities in the RWMH were attributed to incidental hunting during the licensed GRH hunt.
Dyer (1999)	Movement and distribution of woodland caribou (*Rangifer tarandus caribou*) in response to industrial development in northeastern Alberta	– Caribou avoided human disturbance and the amount of avoidance appeared related to the level of human activity. – Caribou did not demonstrate significant avoidance behaviour greater than 250 m from roads and seismic lines. – Seismic lines did not act as barriers to caribou movement while roads acted as semi-permeable barriers.
Bergerud (1996)	Evolving perspectives on caribou population dynamics: have we got it right yet?	– Predation is considered the primary limiting factor for caribou populations in North America, particularly for sedentary herds. – Movement is a key mechanism of predator avoidance for caribou, as well as selection of high quality habitat.
Curatolo and Murphy (1986)	The effects of pipelines, roads and traffic on the movements of caribou, *Rangifer tarandus*.	– Reported that caribou in Alaska crossed roads and pipelines as frequently as control areas. The presence of the Trans-Alaska Pipeline did not appear to affect the traditional migration of the Nelchina caribou herd. – Where a pipeline paralleled a road with traffic, crossing frequencies were significantly lower than expected. – Suggest that vehicles act in a synergistic fashion with a pipeline to produce a negative stimulus that results in decreased crossing frequency.
Northcott (1984)	Movement and Distribution of Caribou in Relation to the Upper Salmon Hydroelectric Development, Newfoundland.	– Caribou tended to avoid the Upper Salmon Hydroelectric Project in Newfoundland during construction. – Individuals altered their dispersal pattern from the post-calving aggregation to avoid encountering traffic on a new access road. – The number of caribou in the area returned to pre-disturbance levels after construction; however, the species exhibited continued avoidance of the road and traffic.

Overall, the studies provide evidence that Caribou can be displaced from development sites, resulting in a functional loss of habitat that exceeds the footprint area. Displacement may be a function of both sensory disturbance and change in predation risk. At the onset of clearing or disturbance, female caribou will typically move away from active disturbance areas, but may return if disturbance ceases. Short-term and small-scale disturbances that are limited in number and distribution may result in temporary displacement of Caribou with little or no long-term population consequence, whereas long-term, larger and more widespread disturbances (e.g., logging) may result in long-term displacement of Caribou due to habitat change, sensory disturbance and increased predation pressure.

Developments such as transmission lines and access roads can also affect Caribou movement, although the literature reflects a range of responses (Table 12.3.5-1). There may be notable differences in behaviour between migratory and sedentary caribou populations in terms of response to linear developments and the extent to which they act as a barrier to movement or migration.

Increased predation may result through habitat change or a change in the distribution of Caribou across the landscape. Any disturbance that creates large scale habitat changes may result in increases in moose densities and may also increase wolf numbers, resulting in increased predation of Caribou. Any changes to habitat that limit the ability of Caribou to disperse freely across the landscape may increase predation pressure.

Hunting is generally considered additive to other limiting factors, such as habitat loss and fragmentation, and may further reduce a declining population or prevent a population from increasing. In areas of unfragmented, high quality habitat with no predator control, Caribou can withstand only 2% to 3% annual hunting mortality (Yukon Renewable Resources 1996, internet site). This annual allowance decreases to zero for Caribou in areas with low quality habitat, multiple predators and human development. Linear corridors associated with development can provide improved access for hunters and poachers. This is particularly true in winter with frozen ground and snow cover, when transmission line ROWs, seismic cutlines and / or winter roads open up previously inaccessible areas.

12.3.5.3 Construction Effects: Central and Southeastern Labrador Caribou and Newfoundland Caribou

Loss or Alteration of Habitat: Central and Southeastern Labrador Caribou

Since the 20 km long access road in Labrador will not fall within Caribou range, clearing to construct the road will have no effect on Caribou habitat.

The total area of the RWMH range is approximately 42,630 km^2. The estimated direct habitat loss from clearing during construction is approximately 3 km^2, which is less than 1% of the total range (Table 12.3.5-2).

The amount of RWMH range falling within the 3 km wide assessment area is 107 km^2 (<1%; Table 12.3.5-2). Some of this area will be subject to habitat alteration due to sensory disturbance, and changes in predation rates may occur. Sensory disturbance effects due to construction are predicted to be similar to those observed by Dyer et al. (2001) for the avoidance of roads by woodland caribou. Woodland caribou avoidance of is predicted to extend no further than 500 m from clearing and other Construction activities, and even within 500 m habitat avoidance is not predicted to be absolute. Of the habitat overlapping with the 3 km wide assessment area for the RWMH, approximately 60% was classified as primary habitat within the winter Caribou range and a similar proportion for calving / post-calving ranges (Table 12.3.5-3).

For the MMH range (49,553 km^2), less than 1% will be affected by the Project (Table 12.3.5-2). Both the approximate habitat loss from clearing (11 km^2) and the approximate amount of range falling within the 3 km wide assessment area (398 km^2) are less than 1% of the total range (Table 12.3.5-2). As with RWMH Caribou, sensory disturbance effects are predicted to extend no further than 500 m from clearing and Construction activities, and even within 500 m habitat avoidance is not predicted to be absolute. Of the MMH habitat occurring within the assessment area, 41% was classified as primary habitat within the winter range and approximately 61% was considered primary within the calving / post-calving range (Table 12.3.5-3).

Table 12.3.5-2 Predicted Changes in Habitat due to Project Related Disturbance within Caribou Range in Central and Southeastern Labrador

Herd	Baseline	Estimated Direct Habitat Loss		Habitat Within the 3 km wide Assessment Area	
	Area (km^2)	Area (km^2)	% of Range	Area (km^2)	% of Range
Red Wine Mountains	42,630	3	<1	107	<1
Mealy Mountains	49,553	11	<1	398	<1

Table 12.3.5-3 Amount of Primary Ranked Habitat within 3 km wide Assessment Area in Central and Southeastern Labrador

Herd	Within Assessment Area			
	Area (km^2) of Primary Habitat – Winter[(a)]	Proportion (%) that is Primary Habitat - Winter[(b)]	Area (km^2) of Primary Habitat – Calving / Post-Calving[(a)]	Proportion (%) that is Primary Habitat – Calving / Post-Calving[(b)]
Red Wine Mountains	64	60	67	63
Mealy Mountains	164	41	242	61

Note: All values were rounded to the nearest whole number therefore totals may contain rounding errors.
(a) Amount of primary habitat (winter or calving / post-calving) that occurs within the boundaries of the assessment area.
(b) Of the range that occurs within the boundaries of the assessment area, the proportion that is primary habitat quality (winter or calving / post-calving).

Loss or Alteration of Habitat: Newfoundland Caribou

For Newfoundland, the NLDEC Wildlife Branch has established different levels of Caribou occupancy (Primary Core area, Secondary Core area, and Occupancy area) based on intensity of use by Caribou. For example, the Primary Core areas (50% kernels) receive greater use than the Occupancy area (100% kernels). The sizes of the occupancy areas on the Island are listed in Table 12.3.5-4. The estimated amount of habitat loss due to clearing during Project Construction is less than 1% in all occupancy areas (Table 12.3.5-4).

The amount of habitat within the 3 km wide assessment area is 3% of the total Primary Core area (158 km^2), 2% of the Secondary Core area (342 km^2) and 2% of the Occupancy area (938 km^2) (Table 12.3.5-4). Some of this area will be subject to potential habitat alteration due to sensory disturbance, and changes in predation rates may occur. However, sensory disturbance effects are predicted to extend no further than 500 m from clearing and Construction activities, and even within 500 m habitat avoidance is not predicted to be absolute.

Within the assessment area, and habitat ranked as primary during winter consisted of 21% of the Primary Core area, 26% of the Secondary Core area and 21% of the total Occupancy area (Table 12.3.5-5). The proportion of habitat ranked as primary in the assessment area during the calving / post-calving season was higher than in winter for all three caribou occupancy kernels (Primary Core area – 55%; Secondary Core area – 59%; Occupancy area – 49%) (Table 12.3.5-5).

Table 12.3.5-4 Changes in Habitat due to Project Related Disturbance within Caribou Occupancy Areas in Newfoundland

Occupancy Area	Baseline	Estimated Direct Habitat Loss		Habitat Within the 3 km wide Assessment Area	
	Area (km^2)	Area (km^2)	%	Area (km^2)	%
Primary Core	4,945	5	<1	158	3
Secondary Core	14,240	11	<1	342	2
Occupancy	57,304	28	<1	938	2

Table 12.3.5-5 Amount of Primary Ranked Habitat within 3 km wide Assessment Area in Newfoundland

Occupancy Area	Within Assessment Area			
	Area (km^2) of Primary Habitat – Winter[(a)]	Proportion (%) of Primary Habitat - Winter[(b)]	Area (km^2) of Primary Habitat – Calving / Post-Calving[(a)]	Proportion (%) of Primary Habitat – Calving / Post-Calving[(b)]
Primary Core	34	21	88	55
Secondary Core	89	26	201	59
Occupancy	199	21	457	49

Note: All values were rounded to the nearest whole number therefore totals may contain rounding errors.
[(a)] Amount of primary habitat (winter or calving / post-calving) that occurs within the boundaries of the assessment area.
[(b)] Of the range that occurs within the boundaries of the assessment area, the proportion that is primary habitat quality (winter or calving / post-calving).

Since it has the highest level of use, habitat alteration and / or loss within the Primary Core area could have the greatest effect on Caribou. The proportion of Primary Core area within the assessment area was 3%, based on the 3 km wide assessment area. However, not all of this area is predicted to be affected, as sensory disturbance effects are predicted to extend no further than 500 m from clearing and Construction activities, and habitat avoidance within the 500 m buffer will not be absolute. Therefore, the 3% disturbance effect calculated for Primary Core area is predicted to be a conservative estimate of the effect.

Caribou have increased vulnerability at certain times of year, such as the calving / post-calving season when calves are most susceptible to predation (Russell et al. 2002). Although only 2% of the total Occupancy area overlaps the assessment area, the proportion of primary habitat in the assessment area during the calving / post-calving season was 49%. This means about half of the Caribou range overlapping the assessment area in Newfoundland is suitable for use by Caribou during the sensitive calving / post-calving period. Habitat alteration and / or loss of this habitat could have negative effects on the Caribou populations overlapping the Project. Disturbances could cause female caribou to change location during the post-calving period and / or select less suitable habitat during this time, and could lead to higher predation risks.

The 12 km long access road at the base of the Northern Peninsula will be constructed within Caribou habitat, and a portion of the road will occur within the 3 km wide construction assessment area. However, the effects of this road on Caribou habitat will be mitigated by aligning the road to avoid Primary Core areas by at least 500 m, to the extent practical. This access road will result in the clearing and loss of approximately 24 ha of habitat based on the planned 20 m wide clearing for the access road, approximately 6 ha of which will be within the 3 km wide assessment area for Caribou.

Overall Loss or Alteration of Habitat during Project Construction

Woodland caribou have been shown to actively avoid certain linear features (Dyer et al. 2002, 2001; Mercer et al. 1985), as well as noise disturbance. Not all caribou, in particular males, are displaced by disturbance and habituation can occur (Schaefer and Mahoney 2007; Nellemann et al. 2001; Vistnes and Nellemann 2001; Nellemann and Cameron 1998; Cameron et al. 1992, 1979). However, habitat suitability, especially for females and young, can be reduced near developments. As females and calves are more easily disturbed than other cohorts (Wolfe et al. 2000), the calving / post-calving period is one of the most sensitive. Other research shows that Caribou may use transmission lines as movement corridors (Jacques Whitford 1997). Thus, while Caribou tend to avoid landscape perturbations, this is not an exclusive situation. They will cross features such as roads, transmission lines and even occupy industrial sites, if they are not disturbed by humans.

Clearing and construction activities associated with this Project will alter habitat availability for woodland caribou through habitat loss or alteration and sensory (e.g., visual, noise) disturbance. Alteration or loss of habitat will occur during all initial physical disturbances associated with the Project. Individuals displaced by the Project will likely move into other habitats and may expand their home range, as observed in Quebec in response to logging activity (Courtois et al. 2007).

Traffic along Project access roads may result in increased displacement of Caribou from these areas, particularly during the calving and post-calving seasons, and could alter movement patterns. Clearing and construction of the transmission line may displace Caribou from work sites by up to 4 km and reduce movement across the ROW. Caribou displaced from development sites may return following cessation of Construction activities (Cumming and Hyer 1998). Because the line will be built in sections, large spans of the ROW will remain undisturbed at any given time (i.e., will occur outside the disturbance zone of influence). Caribou are expected to continue moving through the area during Construction, but may avoid the towers (Vistnes et al. 2004; Nellemann et al. 2001; Vistnes and Nellemann 2001). As such, individuals should be able to cross these features over a wide area, although the transmission corridor will likely be a less attractive area for travel relative to undisturbed locations.

For the RWMH, Schaefer et al. (2000) reported high calving site fidelity, with females returning, on average, to within approximately 7 km of calving sites occupied in the previous year. Decreased access to traditional calving sites may reduce the survival of young if females are forced to calve in unfamiliar or sub-optimal habitats. However there is no evidence that calving habitat or habitat in general is limited across the RWMH range. Although recruitment does not seem to be currently limiting the RWMH, increases in calf mortality could further depress the herd or hinder recovery.

The habitat alteration and / or loss resulting from Project Construction will affect differing amounts of Caribou range in Labrador and Newfoundland. In Labrador, less than 1% of any Caribou herd range falls within the assessment area. For Newfoundland, about 2% of the Occupancy area and 3% of the Primary Core area occur within the assessment area. Although habitat quality was assessed for less than the entire Occupancy area, it is likely that suitable habitat is available throughout the Occupancy area. In addition, the available evidence suggests that hunting and predation, rather than habitat, are the primary limiting factors for the woodland caribou population on the Island of Newfoundland.

Dyer et al. (2001) and Dyer (1999) examined Caribou avoidance by determining their use of a series of different sized buffers around several types of disturbance. The Construction phase of the Project is most similar in nature to “road development in open coniferous wetland” (Dyer et al. 2001; Dyer 1999). Although the 0 to 100 m buffer around roads received very little use, and habitat from 100 to 250 m was significantly avoided, there was no significant avoidance beyond 250 m from the road edge (Dyer 1999), indicating that the disturbance from roads dissipated beyond this point. The available data suggests that avoidance behaviour may occur up to 500 m from roads, but the relationship was not significant due to the reduced strength of the response and the limited sample size. Therefore, there is unlikely to be avoidance by Caribou beyond 500 m from the ROW and associated infrastructure, and much of the 3 km wide assessment area will not be avoided by Caribou.

Although the assessment area overlaps with 3% of the Primary Core area and these areas of overlap contain primary ranked habitat (55%), Nalcor will undertake special management initiatives to limit access and disturbance of calving / post-calving habitat to mitigate these effects.

Direct Mortality from the Project: Central and Southeastern Labrador and Newfoundland Caribou

Although statistics are unavailable, Caribou have been struck by vehicles while attempting to cross the TLH and TCH, and other secondary roads. Mortality of Caribou due to vehicle collisions along access roads could occur and would be highest during Construction when vehicle activity is greatest. Caribou mortality would be most likely during the winter when animals occur between snow berms along roads. Adherence to appropriate speed limits applicable to the size and class of the access roads and signage in known Caribou crossing areas, together with increased awareness training for Project personnel, are likely to minimize the incidence of vehicle collisions.

Indirect Mortality from the Project: Central and Southeastern Labrador and Newfoundland Caribou

Human-related limiting factors include legal and illegal hunting. Until 1959, there were no licenses or hunting quotas in Labrador (Bergerud 1967). The RWMH has been particularly vulnerable in recent years, as its range has overlapped that of the legally hunted GRH which is seasonally accessible via roads in central Labrador. In Newfoundland, the death of one Caribou calf from Corner Brook Lakes (of 15 analyzed by Mahoney and Virgil (2003)) was the result of illegal hunting. Roads may represent a limiting factor for Caribou in varying degrees, through vehicle collisions or by facilitating travel by predators and hunters (Fortin et al. 2008; James and Stuart-Smith 2000; Bergerud 1974). Repeated and excessive disturbance along roads could have energy consequences that could make stressed animals more susceptible to predation.

During Construction, Project access roads as well as the ROW could increase access for various land use activities, such as hunting and trapping. Wildlife mortality due to enhanced access will be mitigated through measures such as employee education, a policy of no harvesting for all on-site Project personnel and decommissioning of temporary access roads when they are no longer required, as appropriate. Additionally, work areas and access roads will be off limits to unescorted non-Project personnel, including during hunting season when work sites are active.

Although legal hunting of the threatened sedentary Caribou herds in Labrador is prohibited, poaching still occurs. Poaching of RWMH Caribou is a serious threat to the viability of the population, and it is possible that the loss of even a few individuals from a herd of less than 100 animals (Schmelzer et al. 2004; Chubbs et al. 2001) could have negative consequences because of the species' low reproductive potential. In Newfoundland, the Caribou population has decreased dramatically (66% since the late 1990s) (Soulliere et al. 2010, internet site). In response, the NLDEC Wildlife Division has reduced the Caribou quota approximately 90% since 2000 (NLDEC 2010b; Newfoundland and Labrador Department of Forest Resources and Agrifoods (NLDFRA) 2000, internet site). In 2011-2012, the quota was 740 Caribou (NLDEC 2011b) and hunter success rates from the 2008 and 2009 hunting seasons were approximately 63% and 73%, respectively (NLDEC 2011b, 2010b).

Caribou populations that share habitat with moose have higher wolf predation rates than those that are spatially separated from moose (Wittmer et al. 2007; Cumming and Beange 1993; Seip 1992). In situations where Caribou habitat alteration and / or loss make the habitat more suitable for moose (e.g., clear-cutting), thereby encouraging range expansion or increases in density, wolf predation rates on Caribou may increase (James et al. 2004; James 1999). Therefore, if the clearing of the transmission corridor created areas suitable for moose, wolf predation of Caribou could increase in these areas. However in Central and Southeastern Labrador moose are scarce through much of the area where the transmission corridor will be located. Wolf predation rates on Caribou (James and Stuart-Smith 2000; James 1999) as well as increased hunting (Boulanger et al. 2004; Bergerud et al. 1984) have also been shown to increase with proximity to linear features. Wolf predation is problematic in Labrador particularly where moose may winter, such as in river valleys. In Newfoundland, where several predators (i.e., black bear, coyote, lynx and bald eagle) contribute to suppressed Caribou recruitment (Blake 2006, internet site), interactions between predators and large prey (e.g., caribou, moose) may be different than in other regions due to the absence of wolves. Therefore, how this predator-prey interaction will change in the presence of habitat alteration and / or loss is unclear.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., brush fire, multiple tower failure, slope failure) on caribou may result in alteration or loss of habitat types and associated human disturbance. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited in scale, the proposed mitigation measures are expected to limit the effect. This also considers the avoidance of the work areas in general by Caribou, which further limits the potential for exposure to any accidents and malfunctions that could happen during Project Construction. The accident most likely to occur is a spill or leak of fuel or lubricants which will be addressed quickly and is not expected to have a measurable effect on Caribou.

Summary of Likely Residual Environmental Effects

The likely residual environmental effects of Project Construction on Caribou as follows:

- Adverse, because there will be habitat alteration and / or loss, temporary sensory disturbances, potential for direct or indirect mortality (vehicle collision, or increased predation / hunting), the possibility of reduced forage availability or access and the potential for changes in migration or movement routes;
- Of low magnitude for Central and Southeastern Labrador and Newfoundland caribou as habitat alteration and / or loss is expected to affect less than 5% of Caribou herd ranges (Labrador) or Primary Core area (Newfoundland);
- Limited to the RSA, because although the effects to habitat are within the LSA, sensory disturbance and avoidance could extend beyond the LSA; and
- Of medium-term to far future duration because although many Construction-related effects (e.g., sensory disturbance) are expected to be limited to the Construction period, habitat alteration / loss and avoidance along the ROW is expected to continue through the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted given the extent of baseline information on Caribou in the province and their habitat, Project information, the understanding of interactions between Caribou and similar types of disturbances throughout their range, and Nalcor's commitment to appropriate mitigation measures (e.g., avoidance of Primary Core area to the extent practical during final siting and alignment of Project components).

12.3.6 Operations and Maintenance

12.3.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

For Caribou, the potential effects during Operations and Maintenance are a continuation of the Construction-related effects. However, in most cases the effects of the Project during Operations and Maintenance are likely to be less than during Construction due to an overall reduction in Project activities during this phase and regeneration of vegetation on the ROW over time. The key issue is related to increased access, which can lead to increased OHV use and increased hunting, poaching, sensory disturbance, and possibly increased predation rates. Secondary issues relate to the presence of the transmission line and ROW and potential interference with movement, and occasional human presence and associated sensory disturbance related to the line maintenance, inspection and vegetation control. Little is known about hearing in Caribou in relation to transmission line noise, which may be an aversive stimulus for migrating Caribou.

To mitigate the potential effect of OHV access and increased hunting, Nalcor will develop access control measures to monitor and manage public OHV use of Project roads and trails. These measures will be applied during the Construction and the Operations and Maintenance phases of the Project. Access control measures will be developed in consultation with regulators and will adapt to changing circumstances as needed.

Disturbances related to inspection, maintenance and vegetation management will, for the most part, be contained within the existing ROW, already cleared during Project Construction. Caribou will still be sensitive to this occasional disruption and disturbance, but it will be of lesser consequence than during Construction, as activities will be infrequent and less intensive. However, the effects of vegetation control will result in the persistence of altered habitat which could result in continued avoidance of the corridor by Caribou, changes in movement or migration paths, or increased predation.

Nalcor has standard mitigation measures used for transmission Operations and Maintenance throughout the province. As during Construction, mitigation measures identified in the Vegetation VEC (Section 12.2.5) would also be effective in limiting effects on Caribou, particularly as related to managing increased OHV access. Mitigation measures relating to Vegetation, as well as measures directly related to Caribou include:

- Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of riparian shoreline(s) will include regular inspection and maintenance of those structures.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.
- Vegetation buffer zones, established at environmentally sensitive areas during construction, will be maintained. Only danger trees will be removed from these areas.
- Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally. Temporary access will be assessed to determine if it will be needed; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the condition of the road or trail.
- Nalcor will decommission those access roads and trails used during construction that are not required for the Operations and Maintenance activities.
- Disturbances related to inspection, maintenance and vegetation management will, for the most part, be contained within the existing ROW, already cleared during Construction.
- Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied as applicable and will be described in the EPP.
- Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods for vegetation removal, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002.
- Ground travel for maintenance of the transmission line will be restricted to existing approved travel routes, which will be used and maintained in accordance with the applicable regulations.
- Transmission line maintenance and repair personnel will adhere to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions.
- Nalcor will implement a policy of no wildlife harvesting during working hours, no feeding, and no possession of firearms or pets by transmission line maintenance and repair personnel.
- Only essential vehicular activity, including helicopter flights, will be permitted along the transmission line corridor to minimize disturbance to wildlife.
- Nalcor will avoid conducting non-essential activity in Primary Core area in Newfoundland during the sensitive calving and post-calving season, to the extent feasible.

- Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task, and any inspections, maintenance and / or repairs will be completed as quickly and efficiently as safety allows.
- Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products.
- Well maintained equipment with quality mufflers will be used and equipment maintenance schedules will be followed.
- Engine idling will be minimized and environmental awareness training with key maintenance and repair personnel will be conducted on this topic.

Nalcor will also employ mitigation measures such as avoiding activity in Primary Core area in Newfoundland during the sensitive calving / post-calving season, as practical.

12.3.6.2 Existing Knowledge

Potential effects on Caribou during Operations and Maintenance of the Project represent a reduced continuation of those effects experienced during Construction, including displacement from habitat and indirect mortality due to increased hunting pressure or predation. While sensitivity to disturbance may be greatest during the Construction or clearing period (Weir et al. 2007; Mahoney and Schaefer 2002; Northcott 1984), the literature indicates that Caribou may habituate to disturbance or that avoidance may continue for some time after disturbance ends (Table 12.3.6-1). The presence of the transmission line may also impede Caribou movements during Operations and Maintenance.

Table 12.3.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Caribou

Reference	Study / Project Context	Summary of Findings
McCarthy et al. (2011)	Effects of natural and anthropogenic disturbance on caribou in Newfoundland	– Studied role of landscape composition in relation to calf recruitment and calving / post-calving range size. – Included disturbance factors (e.g., fire, roads, power lines, agricultural lands) and vegetation types (e.g., coniferous forest, wetlands). – Found that for every additional square kilometre of total disturbance, that individual female's calving / post-calving range increased by approximately 5.4 km^2. – Calf recruitment rates were found to decrease with increasing amounts of disturbance. – The current amount of disturbance in Newfoundland and the resulting fragmentation do not appear to be compressing caribou ranges.
Weir et al. (2007)	Effects of mine development on Woodland Caribou *Rangifer tarandus* distribution	– Examined impact of Hope Brook Gold mine on La Poile woodland caribou herd with monthly surveys from 1985 to 1991. – Following start of construction and during operation, caribou abundance increased with distance from the mine site in all seasons, and caribou avoided areas within 4 km of the site in most seasons. – Within 6 km of the mine centre, group size and the number of caribou decreased as mine activity progressed in late winter, pre-calving and calving seasons; only 17% to 27% of the number of caribou seen during pre-disturbance remained in the study area in these seasons.

Table 12.3.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Caribou (continued)

Reference	Study / Project Context	Summary of Findings
Seip et al. (2005)	Displacement of mountain caribou from winter habitat by snowmobiles	– Recorded caribou on all four census blocks with little or no snowmobile activity, but during 3 of 4 years, observed no caribou on the census block with intensive snowmobile activity. – Caribou observed on the snowmobile block used areas inaccessible to snowmobiles. – Absence of caribou from the intensive snowmobile area during most years could not be explained by differences in habitat quality. – Concluded that intensive snowmobiling displaced caribou from an area of suitable habitat.
Vistnes et al. (2004)	Effects of infrastructure on migration and range use of wild reindeer	– Studied reindeer (*Rangifer tarandus tarandus*) distribution in relation to possible travel barriers (roads and power lines) in south-central Norway, 1997 to 2000, using lichen biomass as an indicator of reindeer use. – Lichen biomass data suggested that wild reindeer used both sides of a closed road in winter, whereas 2 parallel power lines and a winter-closed road in combination reduced reindeer migration and resulted in different grazing pressures on either side of the power lines, even 30 years after the power lines were constructed.
Nellemann et al. (2003)	Progressive impact of piecemeal infrastructure development on wild reindeer	– Surveyed more than 2000 reindeer monthly from 1977 to 1987 before and after the construction (six years following development) of the Blue Lake hydroelectric reservoir. – Following development, reindeer densities within a 4 km radius declined gradually during winter to 8% of pre-development densities without significant changes in undeveloped control sites. – During summer, reindeer gradually reduced use of areas within 4 km distance from roads and power lines to 36% of predevelopment density, with subsequent 217% increase in use of the few remaining sites located >4 km from infrastructure. – Reindeer reproduction declined progressively as habitat was lost.
Dyer et al. (2002)	Quantifying barrier effects of roads and seismic lines on movements of female woodland caribou in northeastern Alberta	– Seismic lines were not barriers to caribou movements, whereas roads with moderate vehicle traffic acted as semi-permeable barriers. The greatest barrier effects were evident during late winter, when caribou crossed actual roads 6 times less frequently than simulated road networks. – The occurrence of a high density of linear features or other disturbances on a landscape may reduce the ability of caribou to move throughout its home range and compromise its ability to disperse across the landscape at low densities; this may crowd individuals into smaller areas and possibly increase its vulnerability to predation.

Table 12.3.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Caribou (continued)

Reference	Study / Project Context	Summary of Findings
Dyer et al. (2001)	Avoidance of industrial development by woodland caribou	– Sensory disturbance may be less of an issue compared to the functional loss of habitat due to avoidance of development and human activity. – Because of the sensitivity of caribou, especially females, to disturbance, and avoidance of development areas (as discussed above), industrial activity could force individuals to crowd or concentrate at higher densities in undisturbed areas, potentially increasing predation risk. – Linear corridors may provide access for wolves into otherwise inaccessible habitat, such as wetland and bog habitats that act as refugia for caribou, resulting in increased predation.
Nellemann et al. (2001)	Winter distribution of wild reindeer in relation to power lines, roads and resorts	– Investigated effects of infrastructure and associated human activity on distribution of wild reindeer during winter in the Nordfjella mountain region of western Norway. – Systematic aerial surveys of the distribution of approximately 2500 reindeer were conducted during late winter 1986 to 1998. – Areas within 2.5 km of power lines were used less than available in six of the eight sampling years, and areas beyond this zone more than expected. – Density of reindeer was 79% lower within 2.5 km of power lines compared with background areas, and increased with increasing distance from infrastructure for comparable habitat. – Areas within 5 km of resorts or from roads and power lines in combination were avoided in all years.
Vistnes and Nellemann (2001)	Avoidance of cabins, roads, and power lines by reindeer during calving	– Investigated avoidance behaviour of calving semi-domesticated reindeer (*Rangifer tarandus tarandus*) near recreational cabins, roads, and power transmission lines in Repparfjord Valley, northern Norway. – Mean reindeer density within preferred habitat was 78% lower in the area <4 km from the tourist resort compared to the area >4 km from the resort. – Mean reindeer density by the power line corridor without traffic was 73% lower in the area <4 km from the power line compared to areas >4 km from the power line for comparable habitat. – Areas <4 km from anthropogenic structures were avoided despite low levels of human traffic and a high proportion of preferred habitat. – Almost 74% of all available forage was located within the avoided 0 to 4 km zones from the resort or the separate power line. – Results suggest that power lines, even without human traffic, may result in substantial reductions in the use of foraging areas.

Table 12.3.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Caribou (continued)

Reference	Study / Project Context	Summary of Findings
James and Stuart-Smith (2000)	Distribution of caribou and wolves in relation to linear corridors	– Tested the hypothesis that linear corridors affect caribou and wolf activities by examining the distribution of 2,616 telemetry locations of caribou, 27 caribou mortality sites, 592 telemetry locations of wolves, and 76 sites where wolves had preyed on large ungulates relative to linear corridors in caribou range and well-drained sites in north-eastern Alberta. – Results indicated that caribou that are close to linear corridors are at a higher risk of depredation. – Caribou mortalities caused by humans were 174 m closer to corridors than all live caribou locations; however, this difference was not significant. – Recommend that development of new corridors within caribou habitat should be minimized and existing corridors should be made unsuitable as travel routes to reduce the impacts of industrial development on caribou populations.
Reimers et al. (2000)	High voltage transmission lines and their effect on reindeer: a research programme in progress	– Reported that caribou habituated to power lines shortly after their construction if additional human disturbance did not occur.
Dyer (1999)	Movement and distribution of woodland caribou (*Rangifer tarandus caribou*) in response to industrial development in northeastern Alberta	– Caribou avoided human disturbance and the amount of avoidance appeared related to the level of human activity. – Caribou did not demonstrate significant avoidance behaviour greater than 250 m from roads in open habitats and from seismic lines. – Seismic lines did not act as barriers to caribou movement while roads acted as semi-permeable barriers.
Cumming and Hyer (1998)	Experimental log hauling through a traditional caribou wintering range	– Reported that, although individuals were displaced 0.9 km to 5 km following snow removal along a winter haul road and avoided the area during the following two months, they returned to the study area the following winter when no disturbance occurred.
Nellemann and Cameron (1998)	Cumulative impacts of an evolving oil-field complex on the distribution of calving caribou	– Investigated changes in distribution and terrain use of calving barren-ground caribou with increasing density of roads in the Kuparuk Development Area, an oil-field region near Prudhoe Bay, Alaska. – In June of 1987 to 1992, caribou density was inversely related to road density, with effects of avoidance most apparent in preferred rugged terrain, comprising important habitats for foraging during the calving period. – Results show that females and calves are more sensitive to surface development than adult males and yearlings, greatest incremental impacts are from construction of roads and related facilities, and the extent of avoidance greatly exceeds the physical "footprint" of an oil-field complex.

Table 12.3.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Caribou (continued)

Reference	Study / Project Context	Summary of Findings
Chubbs et al. (1993)	Responses of Woodland Caribou (*Rangifer tarandus caribou*) to clear-cutting in east-central Newfoundland	– Reported that some caribou moved away from clear-cuts during the summer of cutting and continued to increase their distance from clear-cuts the year after cutting ceased.

12.3.6.3 Operations and Maintenance Effects: Central and Southeastern Labrador and Newfoundland Caribou

Loss and/or Alteration of Habitat

The nature and frequency of activities during Operations and Maintenance will lead to less disturbances to Caribou than during the Construction phase. No additional direct habitat loss is expected during Operations and Maintenance. However, sensory disturbance for Caribou will continue because of the maintained altered landscape along the ROW (i.e., natural succession is interrupted) and to a lesser extent due to infrequent Project activities (e.g., inspection, maintenance, repairs along the transmission line, and vegetation management). Anticipated disturbance along access roads is expected to decline to levels similar to, or slightly above, baseline wherever roads are decommissioned. Caribou may continue to avoid the transmission line corridor and access roads, but less than during Construction. Movements across the ROW are expected to continue, although there may be a reduction in crossing frequency, depending on the location and the habitat type. Although the ROW is narrow, there will be improved access for OHVs which could cause the ROW to be avoided and to act as a permeable barrier to caribou. Vegetation management along the transmission line is scheduled to occur every seven years.Transmission line inspections will be conducted annually, on a rotational basis, with portions of the line scheduled for inspection each year. Inspections of the on-land transmission line may be completed from the air or from the ground. Ground-based inspections will be conducted using all-terrain vehicles (ATVs) during summer and snowmobiles in the winter, and aerial inspections will be conducted by helicopter. Therefore, Project-related human activity will be infrequent.

Given the above, it is not likely that crowding of individuals into smaller areas would occur as a result of landscape disturbance above that occurring at baseline conditions, nor a subsequent increase in predation risk. Development of the ROW is not expected to substantially increase forage availability for moose, and therefore, moose density is not likely to increase due to the Project, suggesting that wolf density and predation pressure on Caribou in Central and Southeastern Labrador will also not increase. Furthermore, development of the ROW is not likely to substantially increase forage availability for moose. As moose numbers along the corridor are not likely to increase measureably, it is predicted that there will be little or no increase in the local predator populations (e.g., wolves in Central and Southeastern Labrador, and coyotes or black bears in Newfoundland) and subsequent predation on Caribou.

Direct Mortality

The main risk of direct Caribou mortality during Operations and Maintenance is from vehicle collisions. However, appropriate speed limits applicable to the size and class of the access roads will help to reduce the potential for vehicle-wildlife collisions. Vehicle use will typically be sporadic along the ROW, isolated and of short duration. Therefore any risk of Caribou mortality from vehicle collision is likely to be minimal.

The herbicide (i.e., Tordon 101 with Sylgard 309 as a surfactant) that Nalcor is proposing to use is non-toxic to wildlife. Sylgard 309 is typically used at relatively low rates and is not likely to be harmful to wildlife. Consequently, no effects from ingestion of forage material from the ROW by Caribou are expected.

Indirect Mortality

A primary concern during Operations and Maintenance is that the Project (i.e., presence of the ROW) may result in increased hunting facilitated by easier access to remote areas. This effect is expected to be limited by the distance of the majority of the ROW from populated areas. Risk of poaching and accidental killing of caribou will be reduced through implementation of Nalcor's policies relating to Project personnel and wildlife. Also, in all regions (Central and Southeastern Labrador, and in Northern Peninsula, Central and Eastern Newfoundland) access control measures will be applied in certain areas and / or to ongoing activities to limit the potential for disturbance of Caribou, as necessary.

Accidents and malfunctions could occur during Operations and Maintenance of the Project, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., brush fire, multiple tower failure, slope failure) on caribou may result in alteration / loss of habitat types and associated human disturbance. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited in scale, the proposed mitigation will likely limit the effect. This also considers the low likelihood for Caribou to be using the habitat within the Project components, which further limits the likelihood for exposure to any accidents and malfunctions that could happen during the Project. The accident most likely to occur is a spill or leak of fuel or lubricants which will be addressed quickly and is not likely to have a measurable effect on Caribou.

Summary of Likely Residual Environmental Effects

The likely residual environmental effects of Project Operations and Maintenance on Caribou are as follows:

- Adverse, because there will be both temporary and permanent sensory disturbances associated with presence of the ROW, potential for direct or indirect mortality (vehicle collision, or increased predation / hunting), the possibility of reduced forage availability or access and the potential for changes in migration or movement routes;
- Of low magnitude for Central and Southeastern Labrador and Newfoundland caribou as habitat alteration and / or loss is expected to affect less than 5% of Caribou herd ranges (Labrador) or Primary Core area (Newfoundland);
- Limited to the RSA, as sensory disturbance and avoidance could extend beyond the LSA; and
- Of far future duration as all effects, including those that occur infrequently associated with specific inspection and maintenance activities and effects associated with the presence of the ROW will continue over the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted given the extent of baseline information on Caribou in the province and their habitat, Project information, the understanding of interactions between Caribou and similar types of disturbances throughout their range, and Nalcor's commitment to appropriate mitigation.

12.3.7 Environmental Effects Summary and Evaluation of Significance

12.3.7.1 Summary of Environmental Effects

The above assessment considered all aspects of Caribou ecology in the province, as well as the likely effects on Caribou from Project Construction and Operations and Maintenance, following application of appropriate mitigation. The likely effects of Construction and Operations and Maintenance on each KI are summarized in Table 12.3.7-1.

Table 12.3.7-1 Environmental Effects Analysis Summary: Caribou

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Central and Southeastern Labrador Caribou	**Adverse** – Project Construction will cause habitat alteration or loss and may cause increased mortality (direct or indirect), reduced forage availability / access and changes in migration / movement routes	**Low** – <5% of Caribou herd ranges will be exposed to the effects of Construction	**Local to Regional** – Although the alteration or loss of habitat is within the LSA, effects such as sensory disturbance and avoidance behaviour occur beyond the LSA but within the RSA	**Medium-term to Far Future** – Project Construction will be limited to four years but effects such as habitat alteration or loss / fragmentation will continue over the life of the Project	**Regular Over a Limited Time Period** – Project activities will occur regularly during the Construction period as different crews move along the ROW; Construction activities will not occur over the entire length of the transmission corridor at one time
Newfoundland Caribou	**Adverse** – Project Construction will cause habitat alteration or loss and may cause increased mortality (direct or indirect), reduced forage availability / access and changes in migration / movement routes	**Low** – <5% of Caribou Primary Core area will be exposed to the effects of construction	**Local to Regional** – Although the alteration or loss of habitat is within the LSA, effects such as sensory disturbance and avoidance behaviour occur beyond the LSA but within the RSA	**Medium-term to Far Future** – Project Construction will be limited to four years but effects such as habitat alteration or loss / fragmentation will continue over the life of the Project	**Regular Over a Limited Time Period** – Project activities will occur regularly during the Construction period as different crews move along the ROW; Construction activities will not occur over the entire length of the transmission corridor at one time
Summary of Likely Residual Construction Effects on Caribou: Construction effects will be adverse. In Central and Southeastern Labrador and Newfoundland the magnitude will be low as less than 5% of Caribou ranges (Labrador) or Primary Core area (Newfoundland) is affected. Effects will be Regional, as many Construction effects, such as habitat alteration and sensory disturbance, can extend beyond the LSA. The effects of the habitat alteration or loss caused by Project Construction, and the opportunities for increased access created by the Project will continue over the life of the Project. Although there are effects predicted to result from the Construction of the Project, Caribou populations are not likely to be affected on a regional scale.					

Table 12.3.7-1 Environmental Effects Analysis Summary: Caribou (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Operations and Maintenance					
Central and Southeastern Labrador Caribou	**Adverse** – Project Operations and Maintenance will cause habitat alteration and may cause increased mortality (direct or indirect), reduced forage availability / access and changes in migration / movement routes	**Low** – <5% of Caribou herd ranges will be exposed to the effects of Operations and Maintenance activities	**Regional** – Effects, such as sensory disturbance and avoidance behaviour occur beyond the LSA but within the RSA	**Far Future** – Although specific Operations and Maintenance activities may be of short duration, some effects, such as those associated with the presence of the ROW and access road (i.e., increased access and habitat alteration or loss / fragmentation) and transmission lines (causing additional sensory disturbance) will continue over the life of the Project	**Infrequent** – Operations and Maintenance activities will occur infrequently when crews are present, but over the duration of the Project

Table 12.3.7-1 Environmental Effects Analysis Summary: Caribou (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Newfoundland Caribou	**Adverse** – Project Operations and Maintenance will cause habitat alteration and may cause increased mortality (direct or indirect), reduced forage availability / access and changes in migration / movement routes	**Low** – <5% of caribou Primary Core area will be exposed to the effects of Operations and Maintenance activities	**Regional** – Effects, such as sensory disturbance and avoidance behaviour occur beyond the LSA but within the RSA	**Far Future** – Although specific Operations and Maintenance activities may be of short duration, some effects, such as those associated with the presence of the ROW and access road (i.e., increased access and habitat alteration or loss / fragmentation) and transmission lines (causing additional sensory disturbance) will continue over the life of the Project	**Infrequent** – Operations and Maintenance activities will occur infrequently when crews are present, but over the duration of the Project
Summary of Likely Residual Operations and Maintenance Effects on Caribou: Operations and Maintenance effects will be adverse for all KIs. In Central and Southeastern Labrador and Newfoundland the magnitude will be low as less than 5% of Caribou ranges (Labrador) or Primary Core area (Newfoundland) are affected. Effects will be Regional, because many effects due to Operations and Maintenance, such as habitat alteration and sensory disturbance, can extend beyond the LSA. Although Operations and Maintenance activities may be infrequent and of short duration, they will continue over the life of the Project. Although there are effects likely to result from the Operations and Maintenance of the Project, Caribou populations are not likely to be affected on a regional scale.					

12.3.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level relative to baseline.

Maintenance of sustainable populations will allow for the continued ecological, cultural and economic role of Caribou into the future. A likely significant adverse residual environmental effect of the Project on Caribou is one that would cause a population decline, such that viability or recovery of that population is threatened. A likely adverse residual environmental effect that does not meet the above criteria is not significant.

In all areas, the effects, which may include habitat alteration and / or loss, possible mortality (direct or indirect), a reduction in forage availability or access and changes to migration or movement routes, are adverse. The 3 km wide assessment area includes the 2 km wide transmission corridor plus a 500 m buffer on either side. This approach of buffering the corridor is consistent with the proposed Environment Canada (2011b) Recovery Strategy for Woodland Caribou, Boreal Population, which defines 'undisturbed habitat' as that beyond 500 m from disturbances. Critical habitat for the MMH and RWMH ranges is defined as 65% undisturbed habitat within the respective ranges. The amount of undisturbed habitat is presently 98% of the MMH range, and 92% of the RWMH range (Environment Canada 2011b). In Central and Southeastern Labrador, the 3 km wide assessment area overlaps with less than 1% of both the MMH and RWMH ranges, and therefore will not affect critical habitat for Caribou in Labrador. In Newfoundland, where Caribou are considered "Not at Risk" (SARA 2011, internet site), 3% of the Primary Core area occurs within the assessment area. The actual amount of habitat affected will be less, as sensory disturbance effects are not predicted to occur beyond 500 m of Project Construction activities or roads.

The likely residual environmental effects of Operations and Maintenance of the Project are similar to, but of lesser magnitude, than those predicted for the Construction phase. Although the individual Operations and Maintenance activities may be of short duration, the duration of effects, including habitat loss or fragmentation and increased access, will continue over the life of the Project. Sensory disturbance effects are not likely to occur beyond 250 m of infrastructure or clearings during Project Operations.

The effects of the Project relative to baseline are not likely to affect the viability or recovery of woodland Caribou populations in Central and Southeastern Labrador and Newfoundland. Therefore, the Project is not likely to result in significant adverse environmental effects on Caribou.

12.3.8 Evaluation of Project Alternatives

A number of Project alternatives have been presented by Nalcor and by stakeholders during consultation activities in support of the Project. Potential effects on Caribou for each of these alternatives, in relation to the proposed (preferred) transmission corridor, are presented in Table 12.3.8-1. Consideration of alternative A8 includes A7, as A8 cannot occur independently.

Table 12.3.8-1 Summary Evaluation of Project Alternative Means: Caribou

Project Alternative Means	Central and Southeastern Labrador[(a)]	Newfoundland[(a)(b)]
A2: Northwest of Strait of Belle Isle Alternative Segment	—	—
A3: Point Amour Alternative Segment	—	—

Table 12.3.8-1 Summary Evaluation of Project Alternative Means: Caribou (continued)

Project Alternative Means	Central and Southeastern Labrador[a]	Newfoundland[a][b]
A4: Strait of Belle Isle Newfoundland Side Alternative Segment	—	—
A5: Great Northern Peninsula (GNP) Northeast Alternative Segment	—	– Similar overlap with Caribou Primary Core area (1% vs. 3%) – Contains a greater proportion of primary winter habitat (79% vs. 28%) – Contains a similar proportion of primary calving / post-calving habitat (84% vs. 82%)
A6: GNP West-central Alternative Segment	—	– Similar overlap with Caribou Primary Core area (1% vs. 2%) – Contains a lesser proportion of primary winter habitat (10% vs. 44%) – Contains a lesser proportion of primary calving / post-calving habitat (16% vs. 60%)
A7: GNP Eastern Long Range Mountains (LRM) Crossing Alternative Segment	—	– Similar overlap with Caribou Primary Core area (0% vs. 1%) – Contains a greater proportion of primary winter habitat (38% vs. 0%) – Contains a greater proportion of primary calving / post-calving habitat (85% vs. 23%)
A7 + A8: GNP International Appalachian Trail Association of Newfoundland and Labrador (IATNL) Alternative Segment[c]	—	– Similar overlap with Caribou Primary Core area (0% vs. 1%) – Contains a greater proportion of primary winter habitat (38% vs. 0%) – Contains a greater proportion of primary calving / post-calving habitat (85% vs. 23%)
A9: Birchy Lake Alternative Segment	—	– Similar overlap with Caribou Primary Core area (0% vs. 0%) – Contains a greater proportion of primary winter habitat (25% vs. 0%) – contains a greater proportion of primary calving / post-calving habitat (50% vs. 0%)[d]
A10: Newfoundland and Labrador Outfitters Association (NLOA) Alternative Segment	—	– Similar overlap with Caribou Primary Core area (0% vs. 5%) – Contains a similar proportion of primary winter habitat (0% vs. 5%) – Contains a lesser proportion of primary calving / post-calving habitat (0% vs. 38%)[e][f]
A11: Avalon Alternative Segment	—	—

— Indicates that caribou distribution does not overlap with this alternative.
(a) The KI for each alternative is the caribou populations that overlap with the alternative.
(b) Comparisons based on amount of caribou Primary Core area present within alternative or proposed transmission corridor.
(c) Calculations for alternative A8 includes A7 (i.e., A7+A8) as A8 cannot be considered independently.
(d) Alternative A9 overlaps Caribou Primary Core areas where the comparable portion of proposed transmission corridor does not.
(e) Alternative A10 does not overlap Primary Core areas where the comparable portion of proposed transmission corridor does.
(f) Only 18% of alternative A10 falls within the ELC boundary therefore the calculations are for that portion only.

The alternatives that overlap with Caribou Primary Core area are A5, A6, A7, A8, A9 and A10. Alternatives A7 and A8 overlap similar amounts of Caribou Primary Core area as the proposed segment; however, they both contain greater proportions of primary habitat in both the winter and calving / post-calving seasons. Alternative A5 is similar to the proposed corridor in all aspects except the proportion of primary winter habitat, which is greater in A5. Alternative A9 also contains greater proportions of primary habitat in both seasons, but this is because the corresponding proposed corridor does not overlap any caribou Primary Core area. Any of these alternatives represent greater habitat alteration and / or loss than the proposed corridor and hence pose a greater risk to the populations affected. Alternatives A6 and A10, however, would result in less habitat alteration and / or loss to affected Caribou populations as both alternatives contain less primary habitat in both seasons than the corresponding proposed corridor. Alternative A6 and the corresponding section of proposed transmission corridor are approximately the same size (46 km^2). However, alternative A10 is 41% larger than the corresponding section of proposed transmission corridor (transmission corridor: 179 km^2; A10: 254 km^2), meaning that although A10 does not overlap anyCaribou Primary Core area, it will affect more Caribou Occupancy area.

12.3.9 Cumulative Environmental Effects

In addition to examining the likely effects of the Project on Caribou, the assessment considers the overall effect on Caribou as a result of the Project's residual environmental effects that overlap both temporally and geographically with those of other projects and activities. Throughout much of the province, the Project crosses areas that are relatively anthropomorphically undisturbed with little development. The future projects and activities considered for the cumulative effects assessment included those with likely overlapping environmental effects within the RSA:

- Lower Churchill Hydroelectric Generation Project – Habitat loss and sensory disturbance from all project activities are predicted to result in a relatively small change in habitat availability and displacement of animals from the RWMH seasonal home ranges. Compared to baseline conditions, construction may result in disturbance increases during calving and post-calving (up to a 5% increase) and winter (less than a 9% increase) seasons. The total amount of disturbance (baseline + project zone of influence) within the ranges will be relatively small, totalling approximately 12% of the calving range, 9% of the post-calving range and 15% of the winter range. The environmental effects of the Generation Project were assessed as not significant to the RWMH.
- Maritime Link – Project construction is scheduled to begin in 2014 and will involve vegetation removal and disturbance to caribou from noise, dust, and general construction activities. Development will occur in Newfoundland between Cape Ray and Bottom Brook along an existing transmission corridor, Bottom Brook to Granite Canal in a combination of existing and new corridors, and Granite Canal to Bay d'Espoir along an existing transmission line.
- TLH3 (Happy Valley-Goose Bay to Cartwright Junction) – both the Project and the TLH involve vegetation removal and disturbance to caribou from noise, dust, and general construction activities. The highway has been operational since 2009, so construction impacts are no longer an issue; however, there is potential for spatial overlap with the Project in terms of disturbance effects to caribou and increased access for hunters.

  Caribou can be affected by future development and upgrades to the TLH in a number of ways. Note that the nearby TLH1 (Happy Valley-Goose Bay to Churchill Falls) crosses the winter and summer ranges of the RWMH. Additional habitat losses due to highway upgrading and hard surfacing are expected to be minimal. However, use of the TLH3 may affect the eastern portion of the RWMH range, with the route passing near known wintering and calving / post-calving areas. TLH3 also bisects the MMH range. This could result in both direct and indirect habitat loss (e.g., habitat fragmentation) for both herds. Increased traffic could deter Caribou from crossing the highway. Although individuals are commonly observed crossing roads and highways, there is evidence that highways may have a filter effect, restricting passage by some individuals or cohorts as traffic levels increase (Cameron et al. 1992; Curatolo and Murphy 1986).

  Fragmentation of Caribou habitat by highways and other linear corridors can increase predation rates by interfering with the ability of the animals to maintain optimal spatial dispersion from predators and other prey. Furthermore, if sedentary caribou in Labrador exist as part of a metapopulation or a group of localized populations (Boulet et al. 2007, 2005) disturbances that disrupt movements and reduce dispersal opportunities could increase the risk of local extinction.

- 5 Wing Goose Bay Military Flight Training – The area used for NATO special forces jet fighter training by 5 Wing Goose Bay was expanded to include most of the range of the RWMH in 1996 (Schmelzer et al. 2004). Because of its proximity to the base, the RWMH had been exposed to particularly high frequencies of aircraft overflights. Several studies and ongoing monitoring by DND have evaluated the effects on caribou of repeated exposure to low-level overflights. Harrington and Veitch (1992, 1991) reported that individuals exhibit overt behavioural responses and changes in movement patterns in response to low-level overflights. During the study, individuals from the RWMH were experimentally overflown by military jet aircraft and helicopters. The authors reported that direct overflights by jet aircraft as low as 30 m above ground level elicited overt responses 88% of the time (Harrington and Veitch 1991).

  Responses typically involved a startle reaction, with animals scrambling to their feet and bolting short distances. Detectable responses were observed just 38% of the time when flights were not directly overhead or were higher than 300 m. Stronger responses (speed of flight, distance moved) were reported when animals were overflown by helicopters than by jets. Harrington and Veitch (1992) also reported lower calf survival in groups of RWMH caribou exposed to overflights. Maier et al. (1998) found that the response of Caribou in Alaska to military jet aircraft varied seasonally. The strongest responses were observed in the post-calving period, when animals exposed to overflights were more active and travelled farther than did those that were not overflown.

  These studies indicate that exposure to training is a disturbance factor for Caribou. Disruption of normal behaviour patterns, including increased movement and reduced foraging and resting time, could have energy consequences that affect the overall health and fitness of affected animals. In 1991, DND implemented an Environmental Management Program that included avoidance measures to minimize effects on the RWMH, GRH (Schmelzer et al. 2004; DND 1994) and more recently, the Joir River Caribou. Although there is little overlap between the Project and the military flight area, there is potential for cumulative effects on Caribou in Labrador, hence the inclusion of discussion regarding military flight training.

- Commercial Forestry Activity – in both Newfoundland and Labrador, forestry practices remove potential habitat for Caribou. The total allowable cuts for the province between 2003 and 2007 were: softwoods in Labrador – 325,000 m^3/year; softwoods in Newfoundland – 2,387,343 m^3/year; and hardwoods in Newfoundland – 127,470 m^3/year (NLDFRA 2003). Clearcutting has been shown to create habitat that Caribou avoid as it does not offer adequate forage or protection from predators. Furthermore, clearcutting can support increases in moose population which can, in turn, lead to an increased population density of wolves and a subsequent increase in predation of Caribou. In Labrador, one of the threats identified by the Recovery Team for the MMH was further forestry activity near Cartwright (Schmelzer et al. 2004). An area representing the core habitat for the RWMH overlaps a portion of commercial forest in Labrador, yet was set aside to reduce potential disturbance effects. Given the threatened status of sedentary herds in Labrador, efforts are underway to define critical habitat that may have implications on future forest harvesting.

- General Economic and Infrastructure Development – infrastructure projects, such as road maintenance / construction, municipal works, and industrial construction, often have localized, short-term construction periods, and are not thought to have significant residual effects on Caribou. Even a large construction project will most likely be limited in scope. The remote nature of the majority of the Project suggests that even if the Project effects do overlap with an infrastructure project, the cumulative effects will be temporary and not significant.

- Parsons Pond Oil and Gas Exploration Drilling – a 5 km access road and three active drill sites on the Northern Peninsula in the vicinity of Parson's Pond could affect Caribou, but activities would not likely overlap with the proposed Project. Construction of the access road, installation and operation of the drill rig, and dismantling and transportation of the drill rig are anticipated to occur within the next 1-2 years, so the majority of activities, with the exception of periodic well testing, will be completed before the Project commences. The access road, however, could have a combined impact with Project infrastructure, as it will contribute to increased access to previously remote areas for hunting and trapping.

- Other Land Uses - Snowmobile trails pass through the centre of the RWMH range, generally following the highway and transmission line corridor, and across the north-western and eastern portions of the MMH range. Labrador Winter Trails Inc. established a network of winter snowmobile trails consisting of old roads, the existing transmission line ROW, and other trails cut to a 6 m width.

  Although disturbance from snowmobiling is a concern, access by snowmobile provides opportunity for illegal hunting. In 2003, poaching accounted for the loss of at least 14 animals from the RWMH and as recently as 2007, three poaching incidents resulted in the loss of 39 individuals from the Lac Joseph Herd and MMH in Labrador (Schmelzer 2010, pers. comm.). As many poaching incidents go undetected, it is difficult to determine the role that illegal hunting has had on the decline of the sedentary Caribou herds in Labrador. Given the status of the RWMH, losses of the magnitude that have been reported are not considered sustainable (Schmelzer et al. 2004). In Newfoundland, the decline in Caribou populations has led to a 90% decrease in available hunting licenses, from 7,460 in 2000 to 740 in 2010. It is unclear what effects the current hunt is having on Caribou populations in addition to the relatively recent effects of coyote predation.

Note that proposed Labrador West mining related developments, Long Harbour processing plant and oil and gas development activities are not in proximity to the Project (i.e., no spatial overlap of Project effects) and do not overlap with the range of the caribou herds / aggregations being considered, so no cumulative effects are likely. Of note, particularly for the Northern Peninsula, Central and Eastern Newfoundland, is the consideration of additional influences on Caribou including ongoing forest operations, mineral exploration, outfitting and other sources of anthropogenic disturbance (e.g., roads). While it is difficult to quantify their influence, the recent data and understanding of Caribou occupancy is a reflection of this activity in the RSA.

The likely effects on Caribou resulting from the Project in certain circumstances can act cumulatively with the effects of existing, planned and reasonably foreseeable projects and activities in the RSA. The overall contribution of the Project to cumulative environmental effects on Caribou is limited due to the mitigation proposed, including use of existing disturbance corridors and access control. As previously stated, the Project effects on Caribou were rated as not significant.

The majority of Caribou populations overlapping the Project are currently decreasing. While research is ongoing, predation (both in Labrador and Newfoundland) and illegal hunting (for Labrador) appear to be the main limiting factors. The availability of suitable habitat has not been identified as a limiting factor for Caribou in Labrador (Schmelzer et al. 2004) although it may be an issue in Newfoundland (Morgan and Doucet 2007). However, the affected populations in Newfoundland do not currently have the same status and, as a result, the cumulative effects may be different than those found in Central and Southeastern Labrador.

The LWCRT, on which Nalcor is an active observer, has developed an extensive Recovery Strategy for threatened woodland caribou herds in Labrador (Schmelzer 2010, pers. comm.). The Strategy addresses many of the information requirements and risk factors described above, including the need to identify and protect critical habitat, enforcement of conservation measures and research to determine the current status and viability of these herds.

Effects on the MMH and RWMH are expected to persist through Operations and Maintenance of the Project. For the RWMH, these effects are likely to be most pronounced in the eastern part of the herd's range (FMD 19A), where landscape changes associated with ongoing forestry operations, along with increased access are likely to affect habitat availability for Caribou. Future forest harvesting operations, not only in FMD 19A (RWMH range), but also through the development of the commercial forest industry near Cartwright (MMH range) will likely result in direct and indirect habitat loss, reducing the size of undisturbed patches of core calving, post-calving and wintering habitat. Although the conservation measures set out in the Forest Ecosystem Strategy Plan represent substantive efforts to reduce the effects of commercial forestry development on the RWMH, it is likely that the overall amount and distribution of effective caribou habitat will change as forest resources in Labrador are exploited.

The MMH (Central and Southeastern Labrador) is the only population considered in this EA to be stable. Furthermore, it appears that the factor preventing the population from increasing is illegal hunting. One goal of the LWCRT recovery strategy is to improve the status of sedentary herds in Labrador. Any increase in wolf predation or illegal hunting combined with any future developments could prevent the herd from increasing, or if sufficiently detrimental, cause the population size to decline. The Project effects on the herd relative to the baseline condition were assessed to be not significant. The cumulative effects of the Project in combination with other projects and activities on the MMH, are also predicted to be not significant.

The RWMH (Central and Southeastern Labrador) is perhaps of greatest concern because the population size is currently estimated to be less than 100 individuals. It is recognized that, in light of the recent population trend and the small number of remaining RWMH Caribou, the herd is likely in peril even if future development in the region, including the Project, do not occur. The Project interaction with the RWMH is limited to the south-eastern portion of the RWMH range and the effects of the Project are overall considered adverse, but are not at a scale that would result in a further decline of this herd. The Project effects on the herd relative to the baseline condition were assessed to be not significant. The overall fate of the RWMH is likely one of continued decline, without the Project, as a result of pressures such as poaching and predation that are ongoing. If these existing (pre-Project) factors remain unchecked, the cumulative environmental effects are predicted to be significant as the herd's viability will be at risk.

For Newfoundland caribou, given the low proportion of Primary Core area likely disturbed for the Project, and other future projects and activities, the cumulative effects are predicted to be not significant. According to Thomas and Gray (2002, internet site): "if sources of mortality such as wolf predation and hunting are managed, caribou may be able to co-exist with well-managed developments". Recent estimates indicate that Caribou populations in the Northern Peninsula, Central and Eastern Newfoundland are declining and studies have shown black bears and coyotes to be important predators, although a clear understanding of the limiting factors has not yet been determined.

Landscape disturbances have the potential to cause the direct and indirect loss of Caribou habitat and additional risk of mortality of individuals. Implementing effective mitigation measures as well as monitoring programs will help to minimize the cumulative effects associated with the Project in combination with other projects and activities. The cumulative effects assessment for Caribou is summarized in Table 12.3.9-1.

Note, all other projects or activities listed in Table 9.3.9-2, are not considered in the cumulative effects assessment on Caribou as these developments do not overlap spatially with the Project and are not in proximity to the RSA, and therefore no cumulative effects are anticipated.

12.3.10 Monitoring and Follow-up

Nalcor is a participating member of the LWCRT, which was established to help protect the sedentary Caribou herds in Labrador, and will continue to support research (such as telemetry work) that will lead to further understanding of the threatened herds.

Nalcor will also consider supporting management interventions that could reverse the decline of the RWMH population, attributed as emigration to the GRH, predation and illegal hunting. Increasing the number of individuals in the RWMH in particular is an important environmental objective. Parameters for monitoring consideration for follow-up that would be directly linked to the effects of the Project could include calf survival, movement and distribution patterns through satellite telemetry, and how extensively Caribou use the areas in the LSA. Follow-up programs will be developed through collaboration with the NLDEC Wildlife Division to determine the most effective and informative program, as appropriate.

Because many developments are likely to occur concurrently within the Caribou range, careful coordination and planning of all resource development and management activities at a regional level is necessary. Such a planning initiative would require participation and commitment by all stakeholders with leadership from the provincial government. For example, in Labrador, the Forest Ecosystem Strategy Plan for FMD 19, prepared by the province and Innu Nation, establishes a precedent for sustainable resource development in the District and may serve as a model for developing an integrated, cumulative environmental effects management framework for the region. Nalcor will work closely with all stakeholders and will be able to assist in such aspects as monitoring and controlling access.

Table 12.3.9-1 Cumulative Environmental Effects Summary: Caribou

Cumulative Effects Analysis	Central and Southeastern Labrador	Newfoundland
Current (Baseline) VEC Condition	**MMH** – The status of the MMH is stable. Although hunting is prohibited (protected by *NLESA* and *SARA*), hunting has been identified as the major threat to the MMH as illegal hunting of the herd, including the Joir River group, has occurred recently. Predation and hunting, and not habitat, are the limiting factors. **RWMH** – The herd's abrupt decline since the late 1980s and recent survey results indicate that the herd has less than 100 individuals, and the herd is protected by *NLESA* and *SARA*. Therefore, the RWMH is particularly vulnerable to disturbances that result in incremental mortality or affect productivity. Predation and hunting, and not habitat, are the limiting factors.	Caribou populations on the Island have declined since the late 1990s, including those in the Northern Peninsula and Central and Eastern Newfoundland. Insular Newfoundland caribou are listed as "Not At Risk". However, all population statuses are decreasing or unknown. Although extensive research is ongoing, the causes of decline (which include predation) are not clearly understood.
Likely Residual Environmental Effects of Labrador-Island Transmission Link	**MMH and RWMH** Residual environmental Project effects include habitat alteration or loss, increased access, alteration or disturbance of movement routes, and sensory disturbance.	Residual environmental Project effects include habitat alteration or loss, increased access, alteration or disturbance of movement routes, and sensory disturbance.
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	**MMH and RWMH** Overlapping projects including the Lower Churchill Hydroelectric Generation Project, TLH3, commercial forestry activity (FMDs 19 and 21), general economic and infrastructure development in the Central Labrador and Labrador Straits region, and other land uses, particularly OHV use, will contribute to habitat loss or alteration and increased potential for mortality due to hunting and increased predation.	Overlapping projects including general economic and Infrastructure development, commercial forestry activity, Maritime Link, Parsons Pond oil and gas exploration drilling, and other land uses, particularly OHV use will contribute to habitat loss or alteration and increased potential for mortality due to hunting and increased predation.

Table 12.3.9-1 Cumulative Environmental Effects Summary: Caribou (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Newfoundland
Cumulative Environmental Effects Summary	**MMH – Not significant** The overall level of contribution of the Project to cumulative effects on caribou is limited due to the mitigation proposed, including use of an existing disturbance corridor (i.e., TLH3) and access control. Also, the transmission corridor is relatively remote thereby reducing activities such as OHV use. The cumulative effects of the Project and other foreseeable projects are not expected to affect the viability of the MMH, therefore the cumulative effects on the MMH are not significant. **RWMH – Significant** The Project interaction with the RWMH is limited to the south-eastern portion of the RWMH range. The effects of the Project are not expected to result in a further decline of this herd. Therefore the Project effects relative to baseline are not significant. In recognition of the present status of this herd, and that other activities and pressures such as poaching and predation may continue, the overall fate is likely one of continued decline with or without the Project. If these existing (pre-Project) factors remain unchecked, the cumulative environmental effects are predicted to be significant, and not a result of the Project effects.	**Not Significant** The overall level of contribution of the Project to cumulative effects on Caribou is limited due to the mitigation proposed (e.g., to the extent practical, avoiding Primary Core area during final alignment of the ROW, use of existing disturbances, and controlling access). Also, the transmission corridor remains relatively remote thereby reducing activities such as OHV use. Considering this, the Caribou population in Newfoundland is predicted to remain viable and, therefore, the cumulative effects are not significant.

Note: The NLDEC is currently using occupancy areas to describe caribou distribution (Blake 2011a, pers. comm.) rather than 'herds' (Dyke 2010, pers. comm.; Saunders 2010, pers. comm.).

12.4 Furbearers

12.4.1 Introduction

As discussed in Section 10.4.6, furbearers are and have been traditionally harvested in Newfoundland and Labrador. Trapping is a source of income and recreation for many residents, and also represents an important Aboriginal cultural tradition in Labrador. Furbearers comprise 20 of 35 known mammal species in Labrador, and 13 of 24 known mammal species in Newfoundland. These species are top predators or omnivores (e.g., marten, lynx, fox, wolf), and herbivores (e.g., porcupine, beaver) that occur in both terrestrial and aquatic habitats. Furbearers are found throughout the province, and most species occupy habitats that overlap the transmission corridor for the Project. Furbearers are important ecologically, economically and culturally, and are indicators of the 'health' of ecosystems, either as predators or as keystone species such as beaver.

Of the Furbearer species with ranges that overlap the transmission corridor, wolverine in Labrador is listed as Endangered and Threatened under Schedule 1 of the *SARA* and the *NLESA*. The Newfoundland subpopulation of marten is also listed as Endangered and Threatened, under Schedule 1 of the *SARA* and *NLESA*.

Marten are trapped and considered to be of cultural and economic importance in Labrador. However, in Newfoundland, their sensitivity to habitat alteration and small population estimates (total of 600 to 800 individuals) has contributed to their listed status (Schmelzer 2008). Wolverine have not been found in Newfoundland, and there is no conclusive evidence that the species is present in Labrador (Fortin et al. 2005). As there is no interaction predicted between wolverine and Project components and, based on their low abundance or possible extirpation from Newfoundland and Labrador, wolverine are not discussed further in this assessment.

The remaining Furbearer species in the province are abundant enough to permit commercial trapping or hunting with some exceptions. Although lynx are trapped in Labrador, trapping of lynx in Newfoundland is only permitted in the Northern Peninsula and a portion of Central and Eastern Newfoundland. Marten and lynx populations are sensitive to habitat and prey changes, while more abundant species such as fox and coyote are generalists that are capable of adapting to available prey species and habitat, resulting in more resilient populations. Arctic hare may also be hunted in Labrador, but are not permitted to be hunted in Newfoundland.

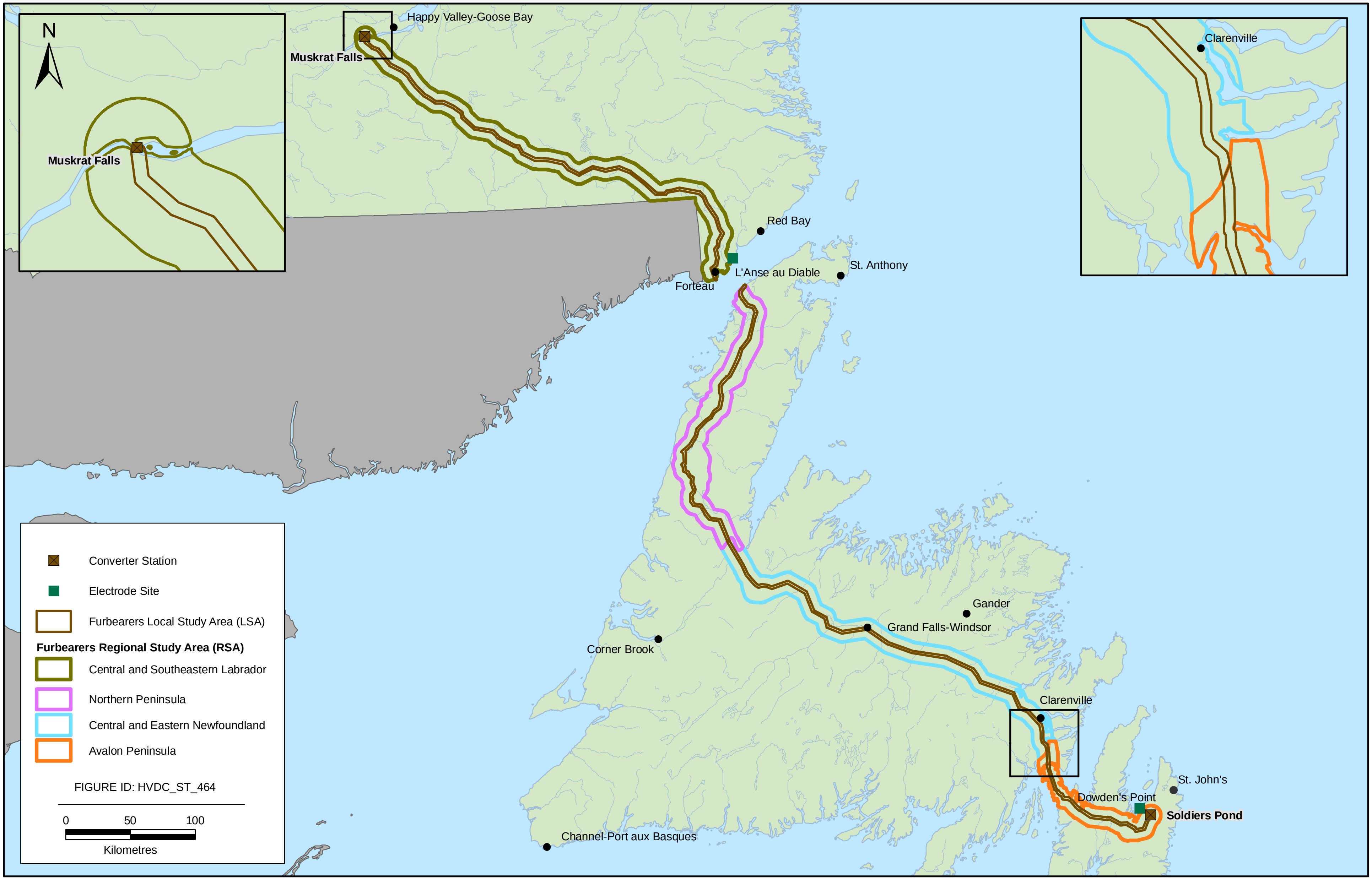
There are regional differences in Furbearer distribution across the province. For example, porcupine, northern flying squirrel, and grey wolf are present in Labrador only. Arctic fox are generally restricted to Labrador, but occasionally cross to Newfoundland on the sea ice. Marten, while abundant in Labrador, are present in only four discrete pockets on the Northern Peninsula and Central and Eastern Newfoundland. All other Furbearers are found throughout Newfoundland and Labrador, including beaver, ermine, mink, river otter, muskrat, red fox, arctic hare, snowshoe hare, lynx, and eastern coyote (a species that has recently colonized Newfoundland and Labrador and is undergoing rapid range expansion) (*SARA* 2011, internet site; Blake 2006, internet site; NLDEC n.d.). The aquatic species (i.e., beaver, river otter, muskrat and mink) demonstrate the most restricted habitat requirements of Furbearers in the province due to their dependence on wetlands and waterways.

12.4.2 Environmental Assessment Study Areas

12.4.2.1 Spatial Boundaries

The LSA is the area where Project-related components and activities that may affect Furbearers will occur. The LSA therefore includes the 2 km wide transmission corridor while also considering the general nature and location of other Project activities and elements (e.g., access, electrode lines, camps, storage areas) (Figure 12.4.2-1).

The RSA is a broader 15 km wide study area that surrounds the LSA (Figure 12.4.2-1). This 15 km wide RSA is consistent with the area for which the ELC was prepared and habitat quality analyses were completed. The RSA was also defined with consideration of the potential spatial extent of other Project-related disturbances, such as noise and dust, which can extend up to 1 km beyond the LSA.



nalcor energy

FIGURE 12.4.2-1

Local and Regional Study Areas for Furbearers

The RSA is large enough to encompass the home ranges of most of the Furbearer species considered in this assessment. Red fox home ranges are approximately 4 to 8 km^2 (CWS and CWF 1993, internet site), typical beaver home range size is approximately 2 km^2 (Aleksiuk 1968), and porcupine have summer home ranges in Labrador of approximately 2.3 to 5.7 km^2 (winter ranges are much smaller) (Schmelzer and Fenske n.d.). A large discrepancy in values has been provided in the literature for marten home range size: from 3 to 10 km^2 in the general literature, to 27 to 45 km^2 in south-eastern Labrador (Nalcor 2009), to 15 to 29 km^2 in Terra Nova National Park (Gosse et. al 2005). It is not practical to assess potential effects at this scale, particularly for a species with such small numbers, so the 15 km wide RSA is considered appropriate for marten, as well as other Furbearer species.

12.4.2.2 Temporal Boundaries

Temporal boundaries for the effects assessment are the Construction phase (approximately 4 years) and the Operations and Maintenance Phase that is assumed to occur in perpetuity.

12.4.3 Potential Environmental Issues, Indicators and Interactions

12.4.3.1 Potential Environmental Issues

As identified in the EIS Guidelines and Scoping Document (GNL and Government of Canada 2011), and through consultation, identified issues and questions are summarized in Table 12.4.3-1. Project-related activities and potential interactions will be similar throughout the province, so it is not necessary to distinguish between geographic regions. Where regional differences do exist (i.e., restriction of porcupine populations to Labrador and differences in the status of marten in Labrador and in Newfoundland), these have been highlighted.

Table 12.4.3-1 Identified Issues and Questions: Furbearers

Issue / Question	Nature and Rationale	Specific Considerations
Habitat alteration or loss as a result of vegetation removal during site preparation and vegetation management	– Trees are used for shelter, protection, feeding, hunting, and raising young – Some species have specific habitat requirements (e.g., beaver forage on deciduous species and occur within and adjacent to watercourses)	– Removal of vegetation / potential habitat for a listed species (i.e., marten) could conflict with management objectives for recovery (particularly removal of important or proposed critical[a] habitat and core areas for marten east of Gros Morne and west of Terra Nova National Parks) – Removal of preferred habitat could cause displacement to areas of lower quality
Change in prey availability as a result of clearing and vegetation management	– Prey species composition and abundance could change as a result of disturbance and edge effects, thereby altering foraging opportunities – May affect the abundance and distribution of predators	– Clearing ROW may remove habitat for species of prey that prefer undisturbed habitat, resulting in their departure from the area – Clearing could increase access for hunting and foraging opportunities for furbearers – Clearing could increase populations of prey species that prefer edge and open habitat – Removal of vegetation could change small mammal prey dynamics in the cleared ROW and along forest edges
Disturbance to individuals as a result of construction and Operations and Maintenance	– Disturbance during Construction, and Operations and Maintenance (e.g., noise and dust) – Harassment due to increased access (e.g., ATV and snowmobile use)	– In addition to direct habitat alteration or loss from clearing, habitat can also be reduced in effectiveness and suitability due to noise and human activity – Reduced habitat availability – May present greater sensitivity during one or more seasons – Reliance on sub-optimal habitat if individuals avoid primary habitat
Direct and indirect mortality as a result of the Project	– Accidental loss through vehicle collisions, or other interaction with Project activities and equipment – Increased hunting, trapping and other harvesting as a result of increased access – Enhanced access for predators – Exposure to chemicals (e.g., oils, lubricants)	– Increased access for hunters and trappers may result in increased mortality – Increased risk to marten in Newfoundland due to increased snaring activities directed at other furbearer species – Increased hunting may become a management issue

[a] Source: NLDEC 2011c.

12.4.3.2 Key Indicators and Measurable Parameters

To focus and frame the effects analysis, KIs for the Furbearers VEC and associated MPs were selected. KIs selected for this VEC include Marten, Red Fox, Porcupine and Beaver. Small mammals are an important component of the ecosystem along the length of the transmission corridor and their influence on furbearers through prey availability was considered as an MP of Project effects on KIs for the Furbearers VEC. Rationale for the selection of both KIs and MPs are described in Table 12.4.3-2.

Table 12.4.3-2 Key Indicators and Associated Measurable Parameters: Furbearers

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Marten	– Sensitive species with limited and isolated areas of high quality habitat in Newfoundland – Newfoundland marten is listed by both *NLESA* and *SARA* – Species of importance to regulators and stakeholders – Economic and cultural importance in Labrador – Indicator of ecosystem health	– Amount (km^2) of primary habitat altered relative to its availability in the RSA	– Reducing, altering or fragmenting primary habitat could affect abundance – Reduced habitat effectiveness can occur due to disturbance – Potential for disruption/ destruction of habitat during denning, mating or rearing due to noise, dust, light disturbance – Potential for harassment by construction workers and recreational users
		– Change in prey availability (km^2 of primary prey habitat altered / available)	– Primary prey species (i.e., meadow vole, southern red-backed vole) populations are potentially affected by Project activities – Prey abundance may change due to habitat alteration (e.g., edge effects, successional vegetation, availability of foraging opportunities)
		– Direct mortality (i.e., the number of mortalities directly attributable to the Project)	– Individuals could be killed by collisions with vehicles or other Project equipment
		– Indirect mortality (i.e., the number of mortalities indirectly attributable to the Project)	– Roads and linear facilities provide increased access for hunters, trappers and predators – Mortality due to avoidance of primary habitat affected by the Project, and exposure to greater predation or harvesting – Desertion of dens and young during Construction, and Operations and Maintenance could cause mortality – Disturbance could stress individual animals, leading to disease or mortality

Table 12.4.3-2 Key Indicators and Associated Measurable Parameters: Furbearers (continued)

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Red fox	– Generalist carnivore common throughout the province; found in any habitat that supports prey – Indicator of ecosystem health – representative of larger carnivore guild that includes lynx, coyote, and wolf (Labrador)	– Amount (km^2) of primary habitat altered relative to its availability in the RSA	– Reducing, altering or fragmenting primary habitat areas could affect abundance; while red fox is a generalist, the proportion of each habitat type affected within a region can be considered – Reduced habitat effectiveness can occur due to disturbance – Potential for disruption / destruction of habitat during denning, mating or rearing due to noise, dust, light disturbance – Potential for harassment by construction workers and recreational users
		– Change in prey availability (km^2 of primary prey habitat altered / available)	– Primary prey species (i.e., snowshoe hare, meadow vole, southern red-backed vole) populations are potentially affected by Project activities – Prey abundance may change due to habitat alteration (e.g., edge effects, successional vegetation, availability of foraging opportunities)
		– Direct mortality (i.e., the number of mortalities directly attributable to the Project)	– Individuals could be killed by collisions with vehicles or other Project equipment
		– Indirect mortality (i.e., the number of mortalities indirectly attributable to the Project)	– Roads and linear facilities provide increased access for hunters, trappers and predators – Mortality due to avoidance of primary habitat affected by the Project, and exposure to greater predation or harvesting – Desertion of dens and young during construction and / or Operations and Maintenance could cause mortality – Disturbance could stress individual animals, leading to disease or mortality

Table 12.4.3-2 Key Indicators and Associated Measurable Parameters: Furbearers (continued)

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Porcupine	– Common throughout Labrador – Cultural significance to Aboriginal groups	– Amount (km^2) of primary habitat altered relative to its availability in the RSA	– Reducing, altering or fragmenting primary habitat areas could affect abundance – Reduced habitat effectiveness can occur due to disturbance – Potential for disruption / destruction of habitat during denning, mating or rearing due to noise, dust, light disturbance – Potential for harassment by construction workers and recreational users
		– Direct mortality (i.e., the number of mortalities directly attributable to the Project)	– Individuals could be killed by collisions with vehicles or other Project equipment
		– Indirect mortality (i.e., the number of mortalities indirectly attributable to the Project)	– Roads and linear facilities provide increased access for hunters, trappers and predators – Mortality due to avoidance of primary habitat, and ineffectiveness of habitat during times of disturbance – Desertion of dens and young during Construction and / or Operations and Maintenance could cause mortality – Disturbance could stress individual animals, leading to disease or mortality

Table 12.4.3-2 Key Indicators and Associated Measurable Parameters: Furbearers (continued)

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Beaver	– Common throughout the province – Requires particular local site conditions for colony establishment, such as an abundance of alder / aspen trees and slow moving waterbodies with rocky substrates	– Number (proportion) of active colonies altered or lost because of the Project	– Dams located along access roads may need to be removed to prevent damage to the road – Disturbance associated with Construction activities may cause the abandonment of colonies
		– Amount (km^2) of primary habitat altered relative to its availability in the RSA	– Primary habitat cannot be mapped for beaver at the scale considered for this Project; general effects on wetland and riparian habitat will be considered as a general indication of the potential for habitat loss – Primary habitat for colony establishment may be affected by Project activities (e.g., clearing, camps, access roads, culverts, bridges) – Specific foraging habitat (i.e., alder and aspen) could be affected – Reducing, altering or fragmenting primary habitat could affect abundance – Potential for disruption / destruction of habitat during denning, mating or rearing due to noise, dust, light disturbance – Potential for harassment by construction workers and recreational users
		– Direct mortality (i.e., the number of mortalities directly attributable to the Project)	– Individuals could be killed by collisions with vehicles or other Project equipment
		– Indirect mortality (i.e., the number of mortalities indirectly attributable to the Project)	– Roads and linear facilities provide increased access for hunters, trappers and predators – Mortality due to avoidance of primary habitat, and exposure to greater predation or harvesting – Desertion of dens and young during Construction and / or Operations and Maintenance could cause mortality – Disturbance could stress individual animals, leading to disease or mortality

Black bears were considered as a potential KI during the process, but were not selected because the effects of the Project on black bears are likely to be negligible and not measurable. The effects on red fox (i.e., same guild as lynx, coyote and wolf) are also representative of the likely effects of the Project on black bears. Black bears are also considered within the Caribou VEC, as a top predator, that could be influenced by increased access resulting from the Project.

12.4.3.1 Potential Project-Furbearer Interactions

The greatest potential effects of the Project on Furbearer KIs are predicted to occur as a result of habitat alteration and loss during Construction (Table 12.4.3-3). Other interactions are related to increased human activity, noise, dust, light pollution, and increased access to previously remote areas. Interactions such as contracting and expenditures or system commissioning, will have no measurable effect on Furbearers and are not assessed further.

During Operations and Maintenance, potential disturbance resulting from maintenance and inspection activities will occur on an infrequent basis, and major repairs could be required, while effects related to increased access could be frequent depending on the location.

Table 12.4.3-3 Potential Project Interactions: Furbearers

Project Phase / Activity	Key Indicator			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Construction				
Construction access trails and roads	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased trapping mortality associated with increased access	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity – Increased hunting and foraging opportunities – Direct mortality due to vehicle collisions – Increased trapping mortality associated with increased access	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased hunting mortality associated with increased access	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Potential contact with hazardous materials accidentally spilled / discharged into watercourses – Direct mortality due to vehicle collisions – Increased trapping mortality associated with increased access
Movement and presence of personnel, equipment and material	– Reduced habitat availability due to sensory disturbance from human activity – Exposure to spills and / or leaks where equipment is operating – Direct mortality due to vehicle collisions	– Reduced habitat availability due to sensory disturbance from human activity – Increased hunting and foraging opportunities – Exposure to spills and / or leaks where equipment is operating – Direct mortality due to vehicle collisions	– Reduced habitat availability due to sensory disturbance from human activity – Exposure to spills and / or leaks where equipment operating – Direct mortality due to vehicle collisions	– Reduced habitat availability due to sensory disturbance from human activity – Exposure to spills and / or leaks where equipment is operating – Direct mortality due to vehicle collisions

Table 12.4.3-3 Potential Project Interactions: Furbearers (continued)

<table>
<tr><th rowspan="2">Project Phase / Activity</th><th colspan="4">Key Indicator</th></tr>
<tr><th>Marten</th><th>Red Fox</th><th>Porcupine</th><th>Beaver</th></tr>
<tr><td>Construction camps</td><td>– Direct alteration or loss of habitat
– Change in prey availability due to alteration or loss of habitat for prey species
– Reduced habitat availability due to sensory disturbance from human activity</td><td>– Direct alteration or loss of habitat
– Change in prey availability due to alteration or loss of habitat for prey species
– Reduced habitat availability due to sensory disturbance from human activity
– Increased foraging opportunities</td><td>– Direct alteration or loss of habitat
– Reduced habitat availability due to sensory disturbance from human activity</td><td>– Direct alteration or loss of habitat
– Reduced habitat availability due to sensory disturbance from human activity potential contact with hazardous materials accidentally spilled / discharged into watercourses</td></tr>
<tr><td>Marshalling yards and staging areas</td><td>– Direct alteration or loss of habitat
– Change in prey availability due to alteration or loss of habitat for prey species
– Reduced habitat availability due to sensory disturbance from human activity</td><td>– Direct alteration or loss of habitat
– Change in prey availability due to alteration or loss of habitat for prey species
– Reduced habitat availability due to sensory disturbance from human activity
– Increased foraging opportunities</td><td>– Direct alteration or loss of habitat
– Reduced habitat availability due to sensory disturbance from human activity</td><td>– Direct alteration or loss of habitat
– Reduced habitat availability due to sensory disturbance from human activity
– Potential contact with hazardous materials accidentally spilled / discharged into watercourses</td></tr>
</table>

Table 12.4.3-3 Potential Project Interactions: Furbearers (continued)

Project Phase / Activity	Key Indicator			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Right-of-way clearing and preparation	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased trapping mortality associated with increased access	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased hunting and foraging opportunities – Increased trapping mortality associated with increased access	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased hunting mortality associated with increased access	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Potential contact with hazardous materials accidentally spilled / discharged into watercourses – Increased trapping mortality associated with increased access
Quarrying and burrowing	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions

Table 12.4.3-3 Potential Project Interactions: Furbearers (continued)

Project Phase / Activity	Key Indicator			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Transmission tower assembly and installation	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity
Conductor installation	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity
Converter station site preparation and construction	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity – Muskrat Falls site only, no interaction at Soldiers Pond site	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to sensory disturbance from human activity	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Muskrat Falls site only, no interaction at Soldiers Pond site	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity
Preparation and construction of submarine cable landing site (on-land works)	—	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to disturbance from human activity, noise, light and increased access	—	—

Table 12.4.3-3 Potential Project Interactions: Furbearers (continued)

Project Phase / Activity	Key Indicator			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Construction and installation of submarine cables (Marine works)	—	—	—	—
Electrode site preparation and installation	—	– Direct alteration or loss of habitat – Change in prey availability due to alteration or loss of habitat for prey species – Reduced habitat availability due to disturbance from human activity, noise, light and increased access – Increased hunting and foraging opportunities	– Direct alteration or loss of habitat – Reduced habitat availability due to disturbance from human activity, noise, light and increased access – Labrador portion of the Project only, no interaction at Newfoundland site	– Direct alteration or loss of habitat – Reduced habitat availability due to disturbance from human activity, noise, light and increased access
Island system upgrades	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity
Employment / presence of workers	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity
Contracting / expenditures	—	—	—	—
System commissioning	—	—	—	—

Table 12.4.3-3 Potential Project Interactions: Furbearers (continued)

Project Phase / Activity	Key Indicator			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Operations and Maintenance				
Operations and maintenance access trails and roads	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased trapping mortality associated with increased access	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased hunting and foraging opportunities – Increased trapping mortality associated with increased access	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased hunting mortality associated with increased access	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Increased trapping mortality associated with increased access
Presence and Operation of the transmission system	– Continued trapping mortality associated with maintained access	– Increased hunting and foraging opportunities – Increased trapping mortality associated with increased access	– Increased hunting mortality associated with increased access	– Increased trapping mortality associated with increased access
Routine line inspections and repairs	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions	– Reduced habitat availability due to sensory disturbance from human activity – Direct mortality due to vehicle collisions – Potential contact with hazardous materials accidentally spilled / discharged into watercourses

Table 12.4.3-3 Potential Project Interactions: Furbearers (continued)

Project Phase / Activity	Key Indicator			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Vegetation management	– Alteration of habitat within ROW – Reduced habitat availability due to sensory disturbance from human activity – Exposure to herbicides	– Alteration of habitat within ROW – Reduced habitat availability due to sensory disturbance from human activity – Exposure to herbicides	– Alteration of habitat within ROW – Reduced habitat availability due to sensory disturbance from human activity – Exposure to herbicides	– Alteration of habitat within ROW – Reduced habitat availability due to sensory disturbance from human activity – Potential contact with hazardous materials accidentally spilled / discharged into watercourses – exposure to herbicides
Potential major system repairs	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity	– Direct alteration or loss of habitat – Reduced habitat availability due to sensory disturbance from human activity – Potential contact with hazardous materials accidentally spilled / discharged into watercourses
Operation of the electrodes	—	—	—	—
Employment / presence of workers	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity – Increased hunting and foraging opportunities	– Reduced habitat availability due to sensory disturbance from human activity	– Reduced habitat availability due to sensory disturbance from human activity
Contracting / expenditures	—	—	—	—

— Indicates no likely or detectable interaction identified.

12.4.4 Approach to the Environmental Effects Analysis

12.4.4.1 Analytical Methods

Baseline conditions were established for each KI using data collected from studies over the last 20 years by the Study Team and others throughout the province, as presented in the Furbearers and Small Mammals Component Study (Stantec 2011e; Stantec 2010e). This baseline report considered species abundance, population density, habitat associations, prey species, and limiting factors. This information regarding the existing environment for Furbearers is summarized in Section 10.3.6.

For the purposes of this assessment, the effects analysis considers the nature and degree of Project-induced change from these baseline conditions. Project-related changes are predicted based on typical effects resulting from similar transmission line or other linear projects, and the experience of Nalcor in construction and operation of electrical transmission infrastructure throughout the province. The assessment considers the nature and degree of Project-induced effects following implementation of standard mitigation practices by Nalcor. Management challenges, such as requirements to avoid areas occupied by marten in Newfoundland, are also discussed.

Habitat alteration or loss due to Project Construction is predicted to have the greatest potential effects on Furbearer KIs. Habitat was classified as primary, secondary, and tertiary, based on the ability of the habitat to provide foraging, protection, natal, and resting habitat. The results of the ELC (Stantec 2011a; Stantec 2010b) were used to identify and quantify, with the use of GIS to query the data, the amount of habitat potentially affected by clearing the ROW (i.e., inform the assessment), assuming a 60 m wide ROW located along the centre line of the transmission corridor, plus a 20% contingency applied as a precautionary approach. As the final alignment of the ROW may occur anywhere within the transmission corridor, this approach is used to provide an estimate of Project effects. In specific areas where identified Newfoundland Marten habitat overlaps the transmission corridor, Nalcor will consult with the NLDEC Wildlife Division to identify the most suitable route for the ROW.

For the purposes of this assessment, a population is defined in one of two ways:

1. For Marten in Newfoundland, populations are defined by polygons of known distribution (i.e., Main River (Northern Peninsula), Little Grand Lake / Red Indian Lake (Central Newfoundland), and Terra Nova (Eastern Newfoundland) (refer to Figure 10.3.6-2, presented in the Existing Conditions discussion)). Conclusions in the effects assessment for Marten are made for those polygons / populations which overlap with the Project.
2. For the other KIs (including Marten in Labrador), populations are defined as they occur within one of four geographic areas defined for the Project, and conclusions are on a geographic region basis, as applicable:
   - Central and Southeastern Labrador;
   - Northern Peninsula;
   - Central and Eastern Newfoundland; and
   - Avalon Peninsula.

Marten

An assessment of likely effects of the habitat altered or lost on Marten populations is based on calculations of the amount of primary habitat potentially altered or lost for the three populations that overlap with the Project: Labrador; Main River (Northern Peninsula) (Figure 10.3.6-3); and Terra Nova (Central and Eastern Newfoundland) (Figure 10.3.6-5).

Within Labrador, predictions of the likely effects on Marten habitat are based on habitat ranking and mapping conducted in association with the Project ELC, as detailed in the Furbearer and Small Mammals Component

Study (Stantec 2011e; Stantec 2010e). Primary habitat for Marten (conifer forest) provides foraging, protection, nesting and resting habitat. Secondary habitat is represented by black spruce / lichen forest, open conifer forest, conifer scrub, hardwood forest and mixedwood forest habitat types. The remaining habitat types were classified as tertiary, based on the provision of limited foraging, protection or resting opportunities.

For Central and Southeastern Labrador, the amount of habitat altered or lost was calculated with a GIS assuming a hypothetical centre line ROW and incorporating a 20% contingency to inform the assessment. A tiered approach was undertaken for consideration of Marten habitat altered or lost within Newfoundland. In descending order of importance, valuable Marten habitat included preferred habitat with Marten present, secondary habitat with Marten present, preferred habitat with no Marten present (but which could be occupied at some point in the future), and secondary habitat with no Marten present. Thus, the assessment considers both Marten presence and habitat quality, as identified through mapping provided by the NLDEC Wildlife Division that could be affected by the Project. The assessment also ranks and maps the remaining habitat within the LSA within the Northern Peninsula and Central and Eastern Newfoundland regions that has the potential to support Newfoundland marten in the future and that may be altered / lost as a result of Project Construction. The quantity of primary habitat for prey species (i.e., southern red-backed vole and meadow vole) that will likely be affected by the Project was calculated based on the results of the ELC and is presented in the assessment as an indicator of the potential effects of the Project on prey availability.

Red Fox

Native to the province, Red Fox is a common generalist predator found throughout a wide range of habitat types. As such, habitat in the LSA or RSA has not been classified as primary, secondary, or tertiary for red fox. Instead, a more general discussion of the overall alteration or loss of habitat types by region and the potential effects of Project activities on Red Fox habitat selection was undertaken for the purposes of this assessment. The quantity of primary habitat of prey species potentially affected by the Project was also calculated based on the results of the ELC and is presented as an indicator to assess the potential effects of the Project on prey availability for Red Fox.

Porcupine

While accurate population estimates for Porcupine in Labrador are not available, an assessment of potential effects of habitat alteration or loss is based on calculations of the amount of primary and secondary habitat potentially affected within the Central and Southern Labrador geographic region (assuming a centre line ROW and including a 20% contingency). Primary habitat for Porcupine was identified as conifer forest, conifer scrub, mixedwood forest and open conifer forest. Secondary habitat is represented by black spruce / lichen, and hardwood forest habitat types. Remaining habitats were classified as tertiary, based on limited foraging, denning, resting or feeding opportunities.

Beaver

Beaver are habitat specialists that require still or slow-moving, permanent surface water with small flow and depth fluctuations for colony construction, and preferentially select sites with an abundance of deciduous cover for feeding (Novak 1987; Northcott 1971). Due to the scale of ELC mapping for this Project, it was not possible to identify the specific habitat requirements for this species, and Beaver habitat was not classified into primary, secondary, or tertiary. Instead, the number (proportion) of active colonies potentially altered or lost because of the Project is discussed. As Beaver are found only in lacustrine, wetland or riparian areas, the effects of Project activities on these types of habitats is also considered.

12.4.4.2 Environmental Effects Descriptors

Environmental effects of the Project on each KI are described using six attributes: direction, magnitude, geographic extent, duration and frequency, providing a comprehensive and systematic analysis (Table 12.4.4-1). Values assigned to the various levels of these descriptors are consistent with other environmental assessments in the province (e.g., Nalcor 2009, Vale Inco Newfoundland and Labrador Limited 2008, Newfoundland and Labrador Refining Corporation 2007). While frequency is not defined in Table 12.4.4-1, it has been used to further describe the potential Project effects on KIs.

Table 12.4.4-1 Effects Descriptors: Furbearers

Effects Descriptor	Definition
Direction[a]	
Adverse	– Habitat loss / alteration / fragmentation – Decreased prey availability – Direct or indirect mortality through vehicle collisions or increased access resulting in increased hunting / trapping pressure
Neutral	– No change in abundance, no net change in habitat or prey availability; no direct or indirect mortality
Positive / Beneficial	– Increased foraging opportunities – Enhancement of habitat quality – Increased access to feeding areas / prey species
Magnitude[b]	
No effect	– No potential effect on KI
Low	– <5% of the population or habitat will be exposed to the effect – Predicted to result in no measurable change in habitat availability or population size relative to baseline conditions
Moderate	– 5% to 25% of the population or habitat will be exposed to the effect – Predicted to result in a measurable change in habitat availability or population size relative to baseline conditions that does not cause management concern
High	– >25% of population or habitat will be exposed to the effect – Predicted to result in a measurable change in habitat availability or population size relative to baseline conditions that does cause management concern
Geographic Extent[c]	
Local	– Environmental effects confined to the LSA
Regional	– Environmental effects confined to the RSA
Beyond regional	– Environmental effects extend beyond the RSA
Duration	
Short-term	– Effect will be evident for less than one year
Medium-term	– Effect will be evident for between one and four years (construction period)
Long-term	– Effect will be evident for longer than four years, but does not extend more than 30 years
Far future	– Effect will be evident throughout Project operations

[a] Degree of change from baseline condition.
[b] Nalcor (2009); Vale Inco Newfoundland and Labrador Limited (2008); Newfoundland and Labrador Refining Corporation (2007).
[c] Spatial area within which an effect may occur.

12.4.5 Construction

12.4.5.1 Overview of Project Construction and Associated Effects Management

Furbearers can be sensitive to habitat loss or alteration and fragmentation, as well as sensory disturbance that will occur with Project Construction activities. Construction involves clearing of vegetation for access roads, trails, construction camps, marshalling yards, staging areas and the ROW. Borrow pits will be established to provide fill for construction. Noise, vibration, lights, and general activity along the ROW during clearing and installation will result in sensory disturbance to Furbearers. Vegetation clearing will result in the greatest potential effect, as it will alter, reduce and / or fragment habitat, will result in disturbance to individuals near the LSA, and could result in a change in prey availability due to the alteration or loss of habitat for prey species. General construction and tower installation (e.g., blasting) could also disturb individuals in the immediate area. Clearing will enhance access for hunters and trappers, as well as predators, such as raptors, coyotes, or foxes that could increase mortality. Vehicle traffic could result in direct mortality (i.e., from collisions with vehicles) and exposure to hydrocarbons or other chemicals from accidental spills could result in injury to individuals.

Nalcor will have mitigation measures in place to limit the potential effect of habitat loss or alteration and fragmentation. This will include using existing disturbed areas and corridors as much as possible, limiting the number of access roads, and decommissioning those roads not required for Operations and Maintenance following construction. Mitigation designed to limit the loss or alteration of vegetation are discussed for the Vegetation VEC (including wetlands and riparian habitat) in in Section 12.2.5 and are considered appropriate for limiting potential effects on Furbearer habitat. In addition, mitigation measures identified in Section 11.2.5 to minimize dust and noise associated with Project Construction are also considered applicable to the Furbearer VEC. Additional mitigation measures employed by Nalcor for transmission line construction elsewhere in the province and applicable to Furbearers include:

- Nalcor will use existing disturbed areas and corridors as much as possible, limit the number of access roads, and decommission roads not required for Operations and Maintenance.
- Existing access roads will be used and development of new access will be minimized, to the extent practical.
- Clearing activities will only occur within the ROW and other site specific areas (e.g., converter station, marshalling yards, camps).
- Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures:
  - all vegetation shall be cut within 150 mm of the surface of the ground;
  - all vegetation that exceeds 2 m height at maturity will be cut;
  - trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed; and
  - merchantable timber will be cleared through various means (e.g., feller-buncher (mechanical), hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m.
- Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats.
- A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

- Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.*
- Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel.
- Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response.
- Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic.
- Well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed.
- During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.
- Haul distances for construction material will be limited to the extent practical.
- Construction activities will be conducted in accordance with municipal by-laws regarding noise.
- High noise-producing construction equipment will be strategically placed as far away as practical from receptors.
- All equipment will have appropriate mufflers and will be well maintained.
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.
- The size of explosive charges will be limited during blasting activities.
- Three hours prior to any blasting, a visual reconnaissance of the area will be undertaken to determine the presence of any wildlife; blasting will be delayed where practical until wildlife have been allowed to leave the area.
- Construction staging areas will be located and operated in a manner that limits disturbance to native vegetation to the extent practical.
- Unless otherwise agreed upon with the NLDEC, all construction materials and debris will be removed from marshalling yards and construction staging areas when Construction is complete, and the areas returned to original land use capability, regraded and allowed to revegetate naturally.
- Nalcor will comply with laws and regulations pertaining to fish and wildlife, forest fires, forest travel, smoking and littering.
- Hardwood vegetation within 30 m of waterbodies occupied by beaver will not be cleared, unless clearing is required for electrical line clearance.
- Culverts will be removed from water crossings of access roads not required for Operations and Maintenance so as not to attract beaver.
- Work areas will be kept clean and organized at all times; crews will collect and dispose of all waste away from the job site, as appropriate.
- Project personnel will take all necessary precautions to prevent and minimize any spillage, misplacement or loss of fuels and other hazardous materials.

- Work activities will occur in a manner that does not deliberately harass wildlife.
- Only essential vehicle use, including helicopter flights, will be permitted within the transmission corridor to limit disturbance to wildlife.
- Project personnel will not be permitted to possess firearms or have pets on-site and Nalcor will enforce a 'no-harvesting' policy during working hours. The exception to firearm possession will be bear monitors as described in the EPP.

Site-specific mitigation measures relating to Furbearers will also be developed prior to and during the Construction phase as necessary. In addition to the above, Nalcor will consult with the Wildlife Division regarding final routing of the ROW in the vicinity of known Marten habitat, particularly within the Northern Peninsula. Detailed imagery of terrain and vegetation cover will be used to identify the most suitable alignment for the ROW near marten core occupancy areas. This would involve the strategic routing of the ROW to minimize the amount of primary and secondary habitat altered or lost and the degree of habitat fragmentation. This exercise would also identify areas where other mitigation options (e.g., restricting the width of the ROW; leaving slash piles within the ROW to provide security areas for Marten) would be implemented.

12.4.5.2 Existing Knowledge

Although Furbearers are usually included under a general 'wildlife' category when assessing the effects of transmission line construction, relevant references are available to inform the effects analysis. The effects of forest harvesting on Furbearers have been studied extensively and are included due to some relevance of the habitat effects (Table 12.4.5-1). However, the cleared 60 m wide ROW is comparable more to issues of access and other linear developments than forestry cutblocks, which tend to be much larger. Studies have also been conducted on the effects of trapper access on Marten and fall and winter diets throughout Labrador in the 1980s and 1990s (Simon et al. 1999a, b). Research conducted in Quebec examined the management implications for Marten in areas where forest harvesting occurs (Potvin et al. 2000).

Table 12.4.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Furbearers

Reference	Study / Project Context	Summary of Findings
Public Service Commission of Wisconsin (2009)	Overview of issues related to construction of electric transmission facilities by others	– Construction and maintenance may affect individual plants and animals, or alter habitat so that it becomes unsuitable – Effects to rare and protected species can usually be avoided or minimized by redesigning or relocating transmission lines based on advanced surveying – In some cases, ROWs can be managed to provide habitat for endangered or threatened species
Van der Ree et al. (2007)	Literature review of barrier effects of roads and in-use mitigation measures	– Effects of roads are diverse, including loss and degradation of habitat; incursion of weeds, disease, and feral animals; direct mortality of wildlife due to collisions with vehicles; disruption of movements due to the creation of barriers; altered microclimatic conditions; and changes to the acoustic environment
Yahner (2004)	Wildlife response to Pennsylvania ROW vegetation maintenance	– Eight species of small mammals were found on ROW, compared to two in adjacent forest – ROW served as a forest clearing

Table 12.4.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
Harron (2003)	Effects of transmission lines and other linear developments on wildlife in Manitoba	– For wolves, transmission lines result mostly in direct mortality through hunting , trapping, and vehicle collisions; also result in enhanced travel opportunities unless also used by hunters, resulting in abandonment of the ROW by wolves – Wolf population and ungulate kill site densities were higher in areas of lower road density – Linear corridors acted as travel corridors for wolves, with average travel speeds almost three times faster than travel speeds in forest – Snowshoe hare abandoned areas for the first year post-clear cut due to a lack of cover. As the site regenerated, they used clear cuts extensively as escape areas in brush, slash piles, and forest edge – Replacement of mature forests with younger growth may increase hare numbers and could therefore benefit predators such as red fox and marten – Lynx and coyote used habitats occupied by snowshoe hare, and shifted habitat selection patterns in response to hare – Forestry clearing may increase the availability of ground herbaceous cover for porcupine in summer and intermediate-aged trees for winter feeding – ROWs and edge communities generally contained the greatest small mammal population density and species richness – Clear cutting for transmission ROWs typically caused an initial decline in populations of small mammals
Mowat and Slough (2003)	Examination of lynx habitat preferences	– Lynx showed strong preference for regenerating habitats – Found mostly in immature pine stands over immature spruce stands – Pine was the preferred browse for snowshoe hare – Lynx regularly travelled on snowmobile trails – Understorey density was higher in preferred habitats – Logging and disease outbreaks in mature forests will create regenerating environments that may benefit lynx – Regenerating clear cuts will rarely support lynx to the same degree as naturally regenerating burns
Simard and Fryxell (2003)	Examination of selective logging and small mammals and arthropods in Ontario	– Removing large trees led to decreased seed productivity, which affected the number of small mammals found at a site – Lower seed productivity resulted in fewer foraging opportunities in selective cut sites compared to pristine stands for small mammals, making cut sites less preferred – Significantly more deer mice were caught in mature stands compared to selectively logged stands

Table 12.4.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
Crooks (2002)	Examination of relative sensitivities of mammalian carnivores to habitat fragmentation (coastal southern California)	– Mammalian carnivores may be particularly vulnerable to local extinction in fragmented landscapes because of their relatively large ranges, low numbers, and direct persecution by humans – Larger carnivores (e.g., mountain lions, bobcats and coyotes) declined as habitat patches became smaller and more isolated – Small to medium-sized carnivores with specialized niches (e.g., spotted skunks, long-tailed weasels and badgers) exhibited relatively small home ranges and high population densities but were detected only in the largest habitat blocks – Small to medium sized generalist carnivores (e.g., gray fox, opossum and feral cat) were able to maintain populations in small and isolated habitat patches
Simon et al. (2002)	Assessment of post-fire and logging small mammal communities in southern Labrador	– Red backed vole abundance was greater in clear-cuts than forested areas due to more coarse woody debris for shelter – Some understorey was greater in clear-cuts (mosses and grasses), but shrubs were more abundant on burned stands
Forsey and Baggs (2001)	Examination of winter mammal activity in riparian and forest areas in relation to clear-cut activities, Copper lake, Newfoundland	– Track abundance (marten, short-tailed weasel, red fox, red squirrel, and snowshoe hare) was higher in forest interior versus riparian habitats, and this difference was statistically significant for marten – Tracks were also more abundant in riparian buffers than in clear-cut / open areas – Track abundance for marten was higher pre-road access – For some environmentally sensitive species (e.g., marten), small disturbances or alterations in habitat caused immediate and significant effects
Hargis et al. (1999)	Examination of effects of forest fragmentation on small mammals and marten in Utah	– A significant decrease in marten capture rates occurred in increasingly fragmented landscapes, and marten were 'nearly absent' from landscapes with less than 25% non-forest cover – Marten capture rates were lower in areas <100 m from open (non-forested) patches – Small mammal densities were significantly higher in clear-cuts versus forests – Habitat fragmentation was a limiting factor for marten populations

Table 12.4.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
Kurki et al. (1998)	Examination of abundance of red fox and pine marten in relation to boreal forest landscapes in Finland	– Increasing proportions of young forest and agricultural land positively affected the track density of red fox – Red fox could cause elevated predation pressure in boreal landscapes fragmented by human activities – Competition or intra-guild predation by red fox did not appear to determine the abundance of pine marten on a landscape scale – Fragmentation of older, closed-canopy forest followed by the increase in younger forest succession stages favoured forest-dwelling generalist predators by increasing the amounts of areas with grass-dominated ground vegetation that are suitable habitat for their preferred prey
Thompson et al. (1989)	Use of track transects to measure the relative occurrence of some boreal mammals in uncut forest and regeneration stands	– Marten track density was higher in uncut areas than in younger stands – Red fox track density was higher in clear-cuts and regenerating stands than in uncut stands
Sturtevant and Bisonnette (1996)	Examination of second-growth forest as potential marten habitat in western Newfoundland	– Marten do not occur in landscapes dominated by open clear cuts, as regenerating forests lack the structural complexity of old growth – *Microtus* were most abundant in areas with openings in the forest canopy – Voles were significantly more abundant in overmature locations, but were virtually nonexistent in very dense stands

Table 12.4.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
Berger (1995)	Overview of effects observed at transmission lines in Manitoba (prepared by Manitoba Hydro) (construction)	– Wildlife are not likely to be seriously affected by disturbance from a transmission line in a limited part of a habitat if extensive areas of similar habitat are present – Transmission lines usually affect only a few individuals, rather than entire populations – The two most important effects were the physical habitat changes and temporary sensory disturbance from the use of machinery and human presence (e.g., noise, exhaust fumes, movement of vehicles and people) – ROW clearing removes relatively small amounts of habitat and clearing may encourage growth of plants that improve habitat for associated species – Clearing critical habitat that supports rare and endangered species could have a negative and possibly severe effect – Cutting openings in continuous forest cover can lead to blowdown, dieback from sun exposure or death / disease from damaged or cut limbs – The magnitude of positive and negative habitat effects depends on the adaptability of the species to environmental change – Garbage, if left on-site, attracts wildlife – Accidental spills of oils, chemicals, fuels and lubricants can damage waterbodies and vegetation – Habitat loss for borrow pits and access roads are short-term – Engine noise and helicopters will disturb wildlife (leading to at least temporary displacement) – Aquatic furbearers will not be displaced unless bank dens, lodges or push-ups are damaged – Terrestrial furbearers may temporarily leave an area, but will normally return after construction is complete – Hunting access may increase as during winter, roads are more useable
Fillier et al. (1995)	Analysis of marten habitat use in the Western Newfoundland Model Forest	– Marten rarely use clear cuts during the first year after cutting and population densities can be up to 60% lower than in continuous forest – As carrying capacity for marten is maximized when up to 25% of the forest is removed, marten may actually benefit from harvesting

Table 12.4.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
Skinner (1995)	Examination of the use of pre-commercially thinned stands by snowshoe hare in the Western Newfoundland Model Forest	– Recently thinned stands provided unfavourable conditions for snowshoe hare – The most important factors affecting habitat selection were browse and cover from predators – Snowshoe hares avoided stands for six years following pre-commercial thinning, as these areas provided inadequate fall and winter cover – Ten years following thinning there was increased use of stands by hare, but still not at the levels seen in un-thinned stands
Thompson (1994)	Examination of marten populations in uncut and logged boreal forests in Ontario	– Densities of marten were higher in uncut forests, individuals here rarely used adjacent logged forests – Marten were significantly older in uncut forests, where they were more productive and had lower rates of mortality – Old growth boreal forests may be preferred because of lower predation risk compared to logged areas
Frederickson (1990)	Examination of the effects of disease, prey fluctuation and clear cutting on marten in Newfoundland	– Changes in marten social spacing appeared to be in response to food resources – Marten of all ages avoided clear-cuts during logging operations and for the first nine months after – Juvenile marten made significantly greater use of clear-cuts, but were still almost three times more likely to use other habitats. Adult marten were approximately eight times more likely to use habitat other than clear-cuts – Increased prey abundance, increased access to prey, and decreased predation risk occurred in uncut areas – Prey were more abundant in uncut forests, although studies elsewhere found prey species were more abundant in clear-cut areas
Tucker (1988)	Assessment of effects of forest harvesting on small mammals in western Newfoundland and significance to marten	– *Sorex* densities were 3 to 5 times higher in logged areas compared to uncut areas – *Sorex* and *Microtus* were both more abundant in regenerating cutovers – Logging had no short-term effects on Sorex abundance – Habitat loss due to forest harvesting is the main obstacle to marten recovery in Newfoundland – Large clear-cuts are detrimental to marten populations; density of marten in commercially cleared forest was about one-third that in undisturbed forest – There are twice as many small mammal prey species available to marten in Labrador than in Newfoundland – Prey availability may be more important that abundance
Snyder and Bissonette (1987)	Examination of marten populations in logged boreal forests in Newfoundland	– Newfoundland marten rarely use forestry clear-cuts, but do make extensive use of small residual areas near clear-cuts

12.4.5.3 Construction Effects – Marten

Forest fragmentation is the most relevant effect of transmission line construction on Marten in the province. Habitat will be altered or lost due to vegetation clearing, and habitat availability will be reduced due to disturbance from human activity, noise, light and dust while construction activities are occurring at a given location. Removal of primary habitat could result in reduced foraging opportunities, as Marten typically avoid open, sparsely vegetated regenerating stands associated with clear-cuts (Graham 2002). Diligent routing of the final ROW in marten core areas in Newfoundland in consultation with the NLDEC Wildlife Division will be designed to limit the loss and fragmentation of primary habitat.

Indirect mortality is possible as a result of increased access to previously remote areas. It is assumed that Marten will leave areas in close proximity to construction activities, but will forage in areas adjacent to the ROW when humans are not present. Chapin et al. (1998) noted that Marten avoided clear-cuts but did not avoid forestry roads. As such, there is potential for Marten to be struck by vehicles on access roads throughout the Construction period.

Movement and presence of personnel, equipment and materials during Construction may result in temporary disturbance and displacement of individual Marten from the immediate area. Transmission tower assembly and tower and conductor installation will present localized disturbance, but transporting materials on-site will be more disruptive over a larger area, as helicopters and large tracked vehicles may be used to bring in larger components. As the Construction is phased, sensory disturbance effects will not occur along the entire transmission corridor at a given time. However, as Construction activities move progressively along the ROW, noise and disturbance would likely result in temporary disturbance to Marten in the immediate area.

In Newfoundland, the converter station is to be installed on the Avalon Peninsula, where marten do not occur (Schmelzer 2008). In Labrador, limited clearing and disturbance associated with construction of the converter station site would have no measurable effect on Marten. Construction of submarine cable landing sites and marine works will have no associated effects on Marten, as these locations are not within areas occupied by this species. The electrode site in Labrador would involve limited clearing and disturbance with no associated effects on Marten. The electrode site in Newfoundland is outside the area of Marten habitat or known distribution and will not have any interaction with the species.

Disturbance may occur during Island system upgrades, as personnel will be present on-site, and small amounts of vegetation removal may be required. System upgrades will occur at the Soldiers Pond converter station, the Holyrood Thermal Generating Station, the Sunnyside Terminal Station, and the Bay d'Espoir Hydroelectric Generating Station. All upgrades will occur within existing ROWs or disturbed areas that are not known to be occupied by Marten.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Marten may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited, the proposed mitigation is expected to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not expected to have a measurable effect on Marten.

Amount of Primary Habitat Altered / Available

Reducing, altering or fragmenting primary (and to some degree, secondary) habitat could have an effect on Marten abundance. Primary habitat (i.e., conifer forest) for Marten provides foraging, protection, denning and resting habitat (Stantec 2010e). Key features of primary habitat include the presence of mature conifer cover with moderate to dense canopy cover and large quantities of course woody debris in the understorey. These habitat attributes provide the optimal mix of prey availability, thermal cover, denning sites and escape cover for Marten. Secondary habitat was identified as black spruce / lichen forest, conifer scrub, hardwood forest, mixedwood forest, and open conifer forest. Calculations for the amount of primary and secondary habitat for marten potentially altered or lost during Construction, assuming the hypothetical 60 m wide centre line ROW plus a 20% contingency to account for access trails and roads and other Project components, are summarized in Table 12.4.5-2. In the following discussions, the values presented for the centre line ROW include the 20% contingency, unless otherwise noted.

Table 12.4.5-2 Primary Habitat for Marten Potentially Affected by Construction (By Region)

Region	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the Centre Line ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	197	26	1,417	25	7	4	<1
Northern Peninsula	135	28	956	24	5	4	<1
Central and Eastern Newfoundland	41	6	244	5	1	3	1
Avalon Peninsula	—	—	—	—	—	—	—

Note: Rounding errors less than 1% may occur in final totals. Calculations for the ROW include the 20% contingency.
— Represents zero values – Marten are not present on the Avalon Peninsula.

Central and Southeastern Labrador

Marten are found throughout Labrador, where they have a broader prey base (numerous small mammal species and snowshoe hare) relative to Newfoundland. Primary Marten habitat occupies 1,417 km^2 (25%) of the Labrador portion of the 15 km wide RSA, while secondary habitat occupies 2,579 km^2 (45%) of the RSA in Labrador.

The effects assessment assumes that Marten are present throughout the RSA in Labrador, and that 7 km^2 of primary habitat will be altered or lost during construction of the ROW. This represents 4% of the primary habitat available in the LSA and less than 1% of the primary habitat available in the RSA. As such, loss of primary habitat to Construction activities will have a small measurable effect on habitat availability at the local scale and little, if any, effect on Marten populations at the regional scale.

Northern Peninsula and Central and Eastern Newfoundland

Previous research (Godbout and Ouellet 2008; Gosse et al. 2005; Poole et al. 2004; Gerrow 2002; Potvin et al. 2000; Hargis et al. 1999; Adair and Bissonette 1997; Bowman and Robitaille 1997; Chapin et al. 1997; Sturtevant and Bissonette 1996; Sturtevant et al. 1996; Drew 1995; Fillier et al. 1995; Lundrigan and Fillier 1995; Thompson and Curran 1995; Thompson 1994; Howes 1993; Schneider and Yodzis, n.d.) has implied that primary habitat for Marten is available only in old growth conifer forest in secluded areas. However, Hearn (2005, internet site) and Hearn et al. (2010) suggest that Newfoundland Marten use a variety of forest types, ages, and compositions. Previous authors concluded that the lack of use of regenerating forest was attributable to avoidance of these habitats by Marten. It is now thought that Marten may be able to exploit these habitats more effectively and the perceived lack of use may be attributable to increased mortality of Marten in these habitats due to accidental snaring and trapping which has been facilitated by increased access to these previously remote areas. Furthermore, territory size for Marten in Newfoundland is exceptionally large (15 to 30 km^2) when compared to Marten elsewhere in Canada (2 to 5 km^2). It may be that Newfoundland Marten are less specific in their habitat choices because there is a limited amount of primary habitat and / or prey species (Hearn 2005, internet site).

As stated in the Analytical Methods (Section 12.4.3.1), the assessment for Newfoundland Marten considers primary and then secondary habitat currently occupied by Marten followed by primary and secondary habitat that is unoccupied but has the potential to be occupied in the future. Newfoundland Marten are found in two core areas that overlap the LSA (i.e., Main River and Terra Nova). The Main River core area for marten is 2,177 km^2, with available suitable Marten habitat over 60% of this area (1,306 km^2) (Stantec 2010e). The Project could result in the alteration or loss of 2 km^2 of vegetation within this area, representing 0.1% of habitat within this core area (Figure 10.3.6-2).

Proposed critical (NLDEC 2011c) habitat for Newfoundland marten has been identified in a draft (but as yet unreleased) provincial recovery plan for this species, which is being considered for adoption by the federal government as a recovery strategy.

Nalcor will consult with the NLDEC Wildlife Division to identify the most suitable alignment for the final ROW and the amount of primary habitat that would be affected. The consultation would involve the strategic routing of the ROW within the LSA to minimize the amount of primary habitat lost and fragmented. Minimization of habitat loss will be accomplished by routing the final ROW through patches of lower quality habitat such as barrens and recent clear-cuts and along existing linear developments such as forestry access roads and existing electrical transmission lines, to the extent practical. To facilitate the final ROW alignment selection process through the Main River core area, Nalcor has compiled aerial photography and LiDAR imagery of the LSA. This highly detailed and accurate imagery has been used to identify areas of primary habitat to be avoided, to the extent practical, such as mature dense coniferous forest. In addition, the use of LiDAR imagery has identified tertiary habitat such as recently harvested areas or barrens that would provide preferred areas for routing the final ROW.

Modifications to the way in which cut timber is disposed of along the ROW will also be considered to reduce the effect of ROW clearing on Marten in the Main River core area. The standard practice is to stack wood along the edge of the ROW in neat piles. Nalcor is considering an alternative approach in this segment of the ROW which would involve creating windrows and brush piles of cut trees and shrubs throughout the ROW. This coarse woody debris would provide cover that would provide connectivity between Marten habitat on either side of the ROW. Once the vegetation on the ROW begins to regenerate, the presence of the coarse woody debris will provide cover for small mammals and foraging opportunities for Marten as well as cover from predators.

For the Terra Nova core area (2,829 km^2), the alteration or loss of 0.4 km^2 of vegetation cover by the Project represents approximately 0.01% of the available habitat in the Core Area (Figure 10.3.6-5). In the Terra Nova core area, the LSA passes through an area of low Marten use. Habitat fragmentation in this core area will be minimized by routing the ROW parallel and adjacent to existing roads and transmission line ROWs.

The above calculations represent the predicted alteration or loss of habitat with known occurrences of Marten. There is additional habitat located within the RSA in the Northern Peninsula and Central and Eastern Newfoundland regions which has been identified as potential primary habitat regardless of whether or not it is currently occupied by Marten. In the Northern Peninsula region, Construction is predicted to affect 4% of the primary habitat that is available for Marten in the LSA, and less than 1% of the primary habitat available within the RSA (Table 12.4.5-2). In the Central and Eastern Newfoundland region, Construction of the Project is predicted to affect 3% of the primary habitat available within the LSA, and 1% of the primary habitat available within the RSA. For the overall RSA (excluding the Avalon Peninsula where no Marten are present), 13% of the total habitat (1,200 km^2) is primary habitat for Marten. Within the RSA for the entire Island (excluding the Avalon Peninsula), 0.6% (7 km^2) of primary habitat will potentially be altered or lost for clearing of the ROW.

Removal of primary habitat within the two core areas may adversely affect resident Marten, as their abundance is relatively low and individuals have large home ranges. Fuller and Harrison (2005) determined that logging practices in close proximity to Marten increased their home range size, most likely because vegetation removal changed forest composition, resulting in smaller trees, open canopies, and reduced subnivean prey access. Younger Marten also used suboptimal habitat if forced from their home range and in direct competition with older Marten. Crowding in these situations could also reduce prey availability, particularly in areas where prey is scarce. However, the level of effects noted for large forestry cutovers would not be expected to be similar to those realized from the clearing of a 60 m wide ROW.

Change in Prey Availability

Two species of vole are important prey for Marten: meadow vole and southern red-backed vole. These species were selected for inclusion in this assessment as they influence Marten survival, occupy specific niches, and can reflect natural disturbances and habitat changes. Meadow voles have historically been an important prey source for Marten in Newfoundland (Folinsbee et al. 1973), but in recent years the southern red-backed vole has also become an important staple of Marten diet as its distribution expands (Rodrigues 2010). Prey abundance may be affected by Construction activities due to habitat alteration or loss, creation of edge habitats, regeneration of successional vegetation, and availability of foraging opportunities.

Table 12.4.5-3 describes the quantity of prey habitat likely to be affected by Project Construction by region. Primary habitat for red-backed vole includes black spruce / lichen forest, conifer forest, conifer scrub, mixedwood forest, and cutover habitat types. Primary habitat for the meadow vole includes conifer scrub, conifer forest, Kalmia lichen heathland, lichen heathland, mixedwood, scrub / heathland / wetland, and wetland.

Table 12.4.5-3 Primary Habitat for Prey Species for Marten (By Region)

Region	Species	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the Centre Line ROW		
		(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	Southern red-backed vole	370	48	1,589	28	14	4	<1
	Meadow vole	739	96	4,939	86	27	4	<1
Northern Peninsula	Southern red-backed vole	194	40	1,153	28	8	4	<1
	Meadow vole	413	85	3,418	84	16	4	<1
Central and Eastern Newfoundland	Southern red-backed vole	361	55	2,097	43	14	4	<1
	Meadow vole	529	81	3,747	77	19	4	<1
Avalon Peninsula	Southern red-backed vole	—	—	–	–	—	—	—
	Meadow vole	—	—	–	–	—	—	—

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.
— Represents zero values – Marten are not present on the Avalon Peninsula, so prey availability is not considered for this region.

In Central and Southeastern Labrador, primary habitat for southern red-backed vole comprises approximately 1,589 km^2 (28%) of the RSA, of which less than 1% could be altered or lost due to Project Construction. Within the LSA, there is 370 km^2 of primary habitat, of which 4% (14 km^2) could potentially be altered or lost for the construction of the centre line ROW. Primary habitat for meadow vole comprises approximately 4,939 km^2 (86%) of the RSA in Central and Southeastern Labrador, of which less than 1% may be altered or lost. Within the LSA, there is 739 km^2 of primary habitat, of which 4% (27 km^2) could be altered or lost based on the centre line ROW.

In Newfoundland (excluding the Avalon Peninsula, where marten are absent and prey availability is not considered), primary habitat for southern red-backed vole comprises approximately 3,250 km^2 (36%) of the RSA, and primary habitat for the meadow vole comprises approximately 7,164 km^2 (80%) of the RSA. Project Construction, based on the centre line ROW, is predicted to affect 8 to 19 km^2 of primary habitat for these two species, by region, which is about 4% of the primary habitat available in the LSA or less than 1% of the RSA (Table 12.4.5-2).

For the core areas of Main River and Terra Nova, the percentage of primary habitat for meadow vole and southern red-backed vole that would be affected by clearing for the centre line ROW was also determined. The amount of primary habitat available for both species is the same as that for Marten. This is to be expected as these species are the main food source for marten in Newfoundland and marten tend to establish their home ranges in areas where these prey species are plentiful. The Main River core area is 2,177 km^2, and the alteration or loss of 2 km^2 of vegetation represents 0.10% of primary vole habitat for this core area (Figure 10.3.6-3). For the Terra Nova core area (2,829 km^2), the potential alteration or loss of 0.4 km^2 associated with the Project represents approximately 0.01% of primary vole habitat in the core area (Figure 10.3.6-5).

For the main prey species of Marten in the province, disturbance of primary habitat for the construction of the ROW is not anticipated to have an effect on populations and abundance. The previous estimates of vole habitat affected are conservative estimates of the amount of microtine prey potentially affected. However, following construction, the ROW will provide primary habitat for meadow vole and secondary habitat for southern red-backed vole. Voles will continue to be common on the ROW, but may be less available to Marten because Marten can be expected to be reluctant to forage in the open habitats associated with the ROW. Implementing the option to place windrows and brush piles within the core areas crossed by the final ROW would help mitigate this avoidance.

There is a potential for disturbance or displacement of individual voles, but the small amount of habitat being affected is not likely to displace individuals to the point of having a negative effect on Marten in Labrador and the two core areas that overlap with the LSA in Newfoundland. Voles are quite tolerant of anthropogenic activities and individuals are unlikely to be displaced more than a few tens of metres. Forced redistribution to new areas may result in increased competition for a short period of time, but this effect would be localized and is not likely to have a measurable effect on Marten populations.

Change in Abundance: Direct Mortality

Marten generally avoid forest edges (Adair and Bissonette 1997) and are unlikely to spend much time along the edges of roads. However, Marten will incorporate active roads into their home ranges (Chapin et al. 1998), implying that they are willing to cross roads during their movements. There is potential for Marten to be struck by vehicles, but the likelihood of vehicle collisions is low compared to mammals such as porcupine and foxes that are slower moving and / or often attracted to roadsides. Adherence to appropriate speed limits applicable to the size and class of the access roads, and awareness of construction crews to be vigilant will help to limit the potential for vehicle-wildlife collisions. Vehicles are expected to be travelling slowly on the ROW due to the terrain, consequently, collisions with Marten are not expected to occur (i.e., Marten could avoid the vehicles).

Exposure to spills and / or leaks where equipment would be operating is unlikely given most wildlife will be at least temporarily displaced from such areas. Furthermore, mitigation measures will be in place to both limit opportunities for such an event to occur and to limit temporal and spatial extent if a spill or leak did occur. Direct mortality is therefore not likely to have an effect on the abundance of Marten populations.

Change in Abundance: Indirect Mortality

Roads and linear facilities provide increased access for hunters / trappers and predators, which may result in increased accidental snaring of Marten and subsequent mortality. Trapping of Marten has been prohibited on the Island since the 1930s, and modified trapping and snaring areas for other species have been implemented adjacent to areas where Marten are found in Newfoundland in order to minimize their accidental capture of Marten. However, there is an increased risk of accidental snaring with traps set for similar-sized Furbearers in newly accessible areas outside the modified trap zones. While this is primarily an issue during Operations and Maintenance, increased access will also be present during Construction. To mitigate this potential effect, access control measures will be developed to manage public OHV use of Project roads and trails. As well, Project personnel will not be permitted to possess firearms on-site, and Nalcor will enforce a 'no-harvesting' policy during working hours. As a result, increased trapping and hunting due to increased access is not likely to have a measurable effect on Marten abundance.

Indirect mortality could result from displacement of Marten from primary habitat. Marten avoid open habitats but will forage along the edges of open habitats (Chapin et al. 1998; Bissonette et al. 1988). Bisonnette et al. (1988) noted that Marten were unlikely to move more than 10 m out into open habitats. They noted only one occurrence of a Marten crossing an opening greater than 200 m wide without using a series of tree clumps. These data suggest that Marten may be reluctant to cross the 60 m wide ROW, particularly immediately after clearing when vegetation heights are low. Implementing the option to create windrows and brush piles will make this effect unlikely to occur. In addition, leaving vegetated buffers along watercourses is predicted to provide favourable crossing points for Marten along the ROW.

The presence of the ROW could result in abandonment of portions of suitable habitat within the home ranges of Marten. The abandoned portions of home ranges may be incorporated into the home ranges of other Marten or may remain unoccupied if they are isolated and not contiguous with suitable habitat. This effect would probably extend beyond the LSA but would not extend past the RSA. It is unlikely that this redistribution of home range habitat would result in Marten mortality or loss of habitat, particularly in Labrador, where Marten are relatively common and widespread on the landscape. This effect may occur in Newfoundland where the amount of suitable habitat is limited and more fragmented, and a substantial portion of the Newfoundland Marten population is present. In Newfoundland (specifically the Main River core area), routing the final ROW to minimize the alteration or loss of Marten habitat and the fragmentation of large patches of suitable habitat, in consultation with the NLDEC Wildlife Division, will make this effect unlikely to occur.

Disturbance

Construction activities typically involve numerous workers, vehicles, and equipment on-site during regular working hours. There is potential for disruption to individual Marten during this phase due to noise, dust, and light disturbance. Noise effects would be the most common, and most prevalent. There is also a risk of disruption to denning / mating / rearing activities, and potential unintentional harassment of individuals by staff. However, while Marten tend to avoid areas of human disturbance such as clear-cuts where open habitats make them more vulnerable to predation, they do not appear to be highly sensitive to sensory disturbance associated with anthropogenic activities. Chapin et al. (1998) noted that the distribution of Marten home ranges did not appear to be influenced by the presence of active forestry roads. In their study, 27 of 28 Marten had forest roads accessible by two-wheel-drive vehicles within their home ranges. Zielinski et al. (2008) found that OHV use in their study area had no apparent affect on Marten occupancy at exposure rates of up to 0.5 vehicle passes per hour.

Although Marten are not expected to abandon suitable habitat in areas that are infrequently disturbed, areas subjected to frequent or long-term disturbance may be abandoned. Sensory disturbance effects would be most likely to occur around active sites such as construction camps, which Marten may avoid for the duration the camp is active. Access roads would probably not be an important source of disturbance for Marten provided that the ROWs are kept as narrow as possible and traffic is intermittent, providing quiet periods when marten can cross roads. Equipment used on-site will be inspected regularly to ensure that mufflers are in good working order to minimize auditory disturbance. Similarly, individual tower construction sites would probably not constitute an important source of disturbance for marten as activities at these sites would only last a few days (i.e., construction will progress along the ROW, with crews working in an area only briefly). Marten are largely nocturnal, so there is likely to be temporal segregation of periods of Marten peak activity and construction activity.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Marten are as follows:

- Adverse, because there will likely be an alteration or loss of primary habitat available in Labrador, near the Main River, and near Terra Nova National Park. There will also be an alteration or loss of habitat in the Northern Peninsula and Central and Eastern Newfoundland regions that could potentially support Marten in the future. Individual Marten may be disturbed within their core areas in Newfoundland, and this is likely to have an adverse effect on these small populations. The removal of mature trees, and subsequent changes to vertical and horizontal structure, may force Marten into adjacent areas of lesser quality habitat, and individuals may have to increase their home ranges to find resources. Also considered, however, was the creation of better quality habitat within the ROW for prey species with potential benefits to Marten. Habitat along the ROW is expected to regenerate to a condition where small mammals, such as meadow vole, will thrive. Forest affiliated small mammals, such as snowshoe hare, would likely forage on the regenerated vegetation along the edge of the ROW, but avoid non-vegetated portions of the ROW.
- Low magnitude, because habitat alteration or loss is expected to affect <1% of the primary habitat available in the RSA for the three Marten populations under consideration. As a result, the Project is predicted to have little if any effect on regional Marten populations.
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA.
- Disturbance-related construction effects are likely to be medium-term, and restricted to active Construction periods. Alteration or loss of habitat along the ROW and access roads required for operations will persist for the far future, as vegetation must be kept short and will likely be comprised of deciduous and grass species (Stantec 2010e) for the life of the Project. Effects of vegetation alteration or loss will be medium-term for temporary access roads, construction camps, storage and laydown areas, as these will be allowed to return to a pre-Construction condition following Project completion.

There is a high degree of confidence that the effect on Marten will not be greater than predicted. This confidence is based on the level of knowledge related to the existing environment and the level of knowledge related to these types of Construction activity. A conservative approach was followed throughout the assessment, which assumed that Marten were actually present in the habitat crossed by the ROW (including the 20% contingency) during the Construction period. However, there is uncertainty about the actual number of individual Newfoundland Marten present in core areas, and as a result it is likely that the approach taken has over-estimated the actual presence of Marten.

Implementation of mitigation measures, assuming Marten are present, will reduce the potential for effects on individuals and populations. These mitigative measures, as discussed above, have been incorporated by Nalcor to minimize direct mortality of marten through trapping or road kill, maintain the connectivity of Marten populations on either side of the ROW, limit the amount of primary and secondary habitat altered or lost in Marten core areas, and limit the degree of fragmentation of suitable Marten habitat in these areas.

12.4.5.4 Construction Effects - Red Fox

Direct mortality (vehicle collisions) and indirect mortality (trapping due to increased access) are the most important factors affecting Red Fox during Construction. Clearing of vegetation for access roads and trails, quarrying and borrowing to obtain construction material, and constructing the ROW and converter stations will also result in habitat alteration or loss and reduced habitat availability due to disturbance from human activity, noise, light and dust.

Red Fox are habitat generalists, and will not be disrupted to the same degree as habitat specific species such as marten. Foxes acclimatize to the presence of humans (Voigt 1987), and individuals may thrive in an area with increased foraging opportunities at or near camps. However, foxes may be killed as nuisance animals at construction sites, or by collisions with construction vehicles. As Red Fox is a generalist species, abundant throughout most habitats in the province (Stantec 2011e; Stantec 2010e), predicted likely effects to Red Fox are expected to be similar across all geographic regions.

Movement and presence of personnel, equipment and materials during Construction of the converter stations, ROW, construction camps, marshalling yards, and staging areas, will likely result in sensory disturbance and temporary dispersal of individual foxes (if present) from the immediate area. Transmission tower assembly and tower and conductor installation will present temporary, localized disturbance that will likely prevent foxes from utilizing habitat in the immediate vicinity of the construction area for the duration of the assembly period (i.e., several days). Disturbance at semi-permanent facilities such as construction camps and marshalling yards will also be intense and will last for several years, depending on the site. At these sites, it is likely that local Red Fox will quickly habituate to the activity. Transportation of materials to and along the ROW will result in widespread, temporary disturbance of relatively low intensity as each disturbance incident will last only a few minutes as vehicles pass. The activities of fox along the ROW are not likely to be adversely affected by these events. When vehicles are in close proximity, Red Fox using the cleared ROW may flee from the ROW, while Red Fox in adjacent habitats may temporarily cease activities.

Site preparation and construction of the submarine cable landing and electrode sites may disturb Red Fox in near-shore areas since small amounts of habitat will be affected, and potential disturbance during typical Construction activities may affect Red Fox near the site. Marine works are not likely to affect Red Fox, but it is possible that foraging at the shore during Construction may be affected by noise and human presence during Construction. Disturbance similar to the construction within the ROW may occur during Island system upgrades since personnel will be present on-site, and small amounts of vegetation removal within the existing ROWs may be required.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Red Fox may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited, the proposed mitigation is expected to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not likely to have a measurable effect on Red Fox.

Amount of Primary Habitat Altered / Available

Reducing, altering or fragmenting habitat could have an effect on Red Fox abundance because even though Red Fox are habitat generalists, some habitat types appear to be more preferred than others. For example, there was no evidence of Red Fox in open conifer forest (Newfoundland), hardwood (Labrador), conifer scrub (Labrador) and burn (Newfoundland and Labrador) habitat types during field work in support of the Project (Stantec 2010b). However, as Red Fox are highly adaptable, calculations of the amount of primary and secondary habitat affected by the Project were not undertaken. A discussion of the potential effect of habitat alteration is presented in terms of effects on prey availability and sensory disturbance.

While Red Fox populations are described as healthy, estimates vary widely, from 10,000 to 100,000 individuals in each of Newfoundland and Labrador (NLDEC 2007). Because of these high numbers, their ubiquitous distribution, and their preference for semi-open areas such as tundra, river valleys, and natural forest openings, it is unlikely that red fox would be negatively affected by removal of habitat for construction of the ROW. Construction is predicted to result in the alteration or loss of no more than 6% (3% on average) of each habitat type within the LSA (Section 12.2.5, Table 12.2.5-4). Although many carnivores have a negative response to habitat fragmentation, medium-sized generalist carnivores such as Red Fox are well-equipped to maintain populations in small and isolated habitat patches (Crooks 2002). In addition, Red Fox appear to prefer clear-cuts and regenerating stands over intact forest (Thompson et al. 1989).

Change in Prey Availability

Red Fox feed on small mammals, snowshoe hare, fish, birds, eggs, insects and berries (CWS and CWF 1993, internet site). Fox are affected by the cyclical nature of small mammal populations (Sklepkovych and Montevecchi 1996), so any potential effects of construction on small mammal populations along the ROW (Section 12.5.5.3) could potentially affect prey availability and the health or distribution of Red Fox populations. However, while the initial clearing of the ROW will result in reduced availability of small mammals, small mammal abundance will increase as vegetation along the ROW regenerates. The early successional habitat maintained on the ROW will provide primary habitat for meadow vole and secondary habitat for southern red-backed vole.

The managed vegetation on the ROW may not provide enough overhead and lateral cover for larger prey animals such as snowshoe hare. These species may feed along the edge, but are not expected to forage in open areas on the ROW.

Change in Abundance: Direct Mortality

Red Fox mortality could occur due to vehicle collisions during the Construction Phase. This species is often found around areas of human activity, including road ROWs. Adherence to appropriate speed limits applicable to the size and class of the access roads, and awareness of Project personnel to be vigilant to avoid wildlife collisions to the extent practical will help to minimize the potential for wildlife-vehicle collisions. Where speed limits are maintained at 50 km/h or less, the probability of vehicle collisions with Red Fox is low.

Change in Abundance: Indirect Mortality

Alteration or loss of vegetation for the ROW and construction of access roads will increase access for hunters and trappers and may increase mortality due to increased number of snares and trap lines. As with marten, this potential issue will continue into the Operations and Maintenance phase, and will depend on the proximity to a human population base. To mitigate this potential effect, access control measures will be developed to manage public OHV use of Project roads and trails. As well, Nalcor will not permit Project personnel to possess firearms on-site, and will enforce a 'no-harvesting' policy to limit potential effects on Red Fox abundance.

Indirect mortality could result from displacement, as increased predation could occur in sub-optimal habitats and competition for food and shelter resources could result in decreased individual health and productivity. Indirect mortality can also be attributed to avoidance of primary habitat due to sensory disturbance and the resultant exposure to greater predation and harvesting risk, as well as desertion of dens and young during the Construction phase. Sensory disturbance could also lead to individual stress, which could then lead to disease or mortality. Indirect mortality as a result of exposure to spills and / or leaks where equipment would be operating is unlikely given that most wildlife will be at least temporarily displaced from such areas. Mitigation measures will be in place to both limit opportunities for such an event to occur and to limit temporal and spatial extent if a spill or leak did occur. Given the highly adaptable nature of Red Fox and its ability to easily habituate to the presence of humans, it is unlikely that there will be an increase in Red Fox mortality associated with avoidance of primary habitat.

Disturbance

Construction activities typically involve the presence of numerous workers, vehicles, and equipment on-site during regular working hours. There is the potential for disruption to individual Red Fox during this phase due to noise, dust, and light disturbance. There is also a risk of disruption to denning, mating and rearing areas, and potential unintentional harassment of individuals by construction personnel. Noise effects would be the most common, as they are further reaching and may extend into the RSA for such activities as the movement of materials along access routes. However, most of the noise associated with the Project would be limited to the LSA.

Red Fox are highly tolerant of anthropogenic activities and are unlikely to be negatively affected by disturbance events. Short-term sensory disturbance events, such as vehicle traffic, will likely have minor disturbance effects on foxes. Foxes would be most affected in situations where they can see, smell or hear humans and these stimuli are concentrated at work sites. Under these circumstances foxes can be expected to leave the area where the disturbance is occurring, but are unlikely to move great distances. If the disturbance persists and has no negative consequences for the foxes, they can readily habituate to human activities. Equipment used on-site will be inspected regularly to ensure that mufflers are in good working order to minimize auditory disturbance. If the presence of human activities results in the availability of food, foxes may be attracted to areas such as construction camps and may become a nuisance or even a health hazard if rabies is present in the local population. However, proper waste handling will be practiced, prohibitions regarding the feeding of wildlife will be in effect, and wildlife encounter training will be provided to personnel. These mitigations will likely reduce the level of disturbance to wildlife such as Red Fox and minimize the potential for them to be destroyed as nuisances or health hazards at Project facilities.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Red Fox are predicted to be similar across the province and are as follows:

- Adverse, because there is an alteration or loss of available habitat. However, there will also be some positive benefits, as Red Fox adapt to fragmentation and the ROW may result in increased foraging and hunting opportunities. Habitat on the ROW is expected to regenerate to a condition where small mammals such as meadow vole will thrive. Forest affiliated small mammals, such as snowshoe hare, would likely forage on the regenerated vegetation along the edge of the ROW, but avoiding non-vegetated portions of the ROW.
- Low magnitude, because habitat alteration or loss will be minimal, and, while individuals may be affected, this is not expected to jeopardize the sustainability of individual populations. The removal of potential habitat is not limiting in this case because foxes will quickly move and adapt to available habitat.
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA.
- Disturbance-related Construction effects are predicted to be medium-term, and restricted to active construction periods. Alteration or loss of habitat along the ROW and access roads required for operations will persist into the far future, as vegetation must be kept short and will likely be comprised of deciduous and grass species for the life of the Project. Effects of vegetation alteration or loss will be medium-term for temporary access roads, construction camps, and storage and laydown areas, as these will be decommissioned and allowed to return to a pre-Construction condition following Project completion.

There is a high degree of confidence that the effect on Red Fox will not be greater than predicted. This confidence is based on the information available on the existing environment and knowledge of similar effects if this type of activity. A conservative approach was taken throughout the assessment, which assumed that there are Red Fox present in the habitat crossed by the ROW (including the 20% contingency), and that they will not leave the immediate area at the start of Construction. The mitigation measures committed to by Nalcor to limit adverse effects to habitat and disturbance to animals are expected to minimize effects on Red Fox.

12.4.5.5 Construction Effects – Porcupine

Porcupine are not found in Newfoundland, and therefore the following discussion addresses effects of the Project on Porcupine in the Central and Southeastern Labrador region only.

Increased hunting-based mortality associated with increased access provided by the ROW and access roads is likely to be the most relevant effect of Project Construction on Porcupine in Labrador. Mortality through vehicle collisions, habitat alteration or loss and habitat fragmentation are also factors that could affect Porcupine populations. Construction involves the clearing of vegetation for access roads and trails, followed by quarrying and borrowing to obtain construction material. Porcupine will use both deciduous and coniferous species for feeding and resting, so removal of tree cover from the ROW will potentially affect porcupines in the area. Trees (bark, twigs, buds and needles) are an important winter food source for porcupine. During the summer months Porcupine feed extensively on ground vegetation species and are less dependent on trees as a food source. Trees also provide escape cover for Porcupine and large hollow trees, when available, can provide den sites.

Disturbance associated with human activity can prevent Porcupine from using suitable habitat. However, this species is generally quite tolerant of human activities and are often attracted to areas of ongoing human activities such as roadsides and camps that provide sources of food and salt. Spring vegetation development in Labrador occurs about a week earlier on roadsides than in forested areas, and this early flush of vegetation attracts Porcupine to roadsides in the spring (Schmelzer and Fenske n.d.). Areas where road salt is applied often attract Porcupine. Salt residues on items such as hand tools and seats may also attract Porcupine and can result in them becoming a nuisance when they chew these items. Disturbance is most likely to adversely affect Porcupine in areas where Construction activity is ongoing and consists of a mixture of noise and olfactory stimuli.

Porcupine have poor vision and often do not respond to visual stimuli until they are quite close. Nonetheless, human activities at tower construction sites, camps and marshalling areas may cause porcupine to avoid otherwise suitable habitat. However, it is unlikely that Porcupine will shift their distribution more than few hundred metres in response to disturbance. Once the disturbance ends, they can be expected to quickly return to the area. Short-term, low intensity disturbance such as vehicle traffic along access roads and the ROW are unlikely to disturb Porcupine, particularly if they are present in adjacent forested areas rather than on the cleared ROW. Porcupine will habituate to non-threatening human activities and are often observed foraging along roadsides near heavy traffic. Over time, Porcupine may habituate to the presence of human activities at construction camps and marshalling yards.

Porcupine are a game animal in Labrador and in accessible areas hunting can be an important cause of mortality. Schmelzer and Fenske (n.d.) found that 44% of their study animals were killed or presumed killed by hunters. The construction of the ROW and access roads will provide increased access that could result in increased Porcupine mortality.

Converter station site preparation and construction, and construction of the submarine cable landing site will have a lesser effect on Porcupine, as small amounts of habitat will be removed, and potential disturbance during typical Construction activities may affect Porcupines near the site. Marine works are not anticipated to have any effects on Porcupine.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Porcupine may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited, the proposed mitigation will likely limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not likely to have a measurable effect on Porcupine.

Amount of Primary Habitat Altered / Available

Reducing, altering or fragmenting primary (and to some degree, secondary) habitat could have an effect on the abundance of Porcupine. Primary habitat for porcupine includes conifer forest, conifer scrub, mixedwood forest and open conifer forest. Primary habitat comprises 60% (3,749 km^2) of the RSA and 71% (500 km^2) of the LSA in the Central and Southeastern Labrador region (Stantec 2011e). Approximately 4% (21 km^2) of the primary habitat available within the LSA and less than 1% within the RSA is predicted to be lost or altered due to construction of the ROW (assuming a centre line ROW and 20% contingency) (Table 12.4.5-4).

Table 12.4.5-4 Primary Habitat for Porcupine

Region	Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the Centre Line ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	550	71	3,749	60	21	4	<1

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency. Numbers are not presented for Newfoundland because porcupine are not present on the Island.

The loss of primary forested habitat along the ROW will reduce the availability of winter feeding habitat and summer roosting sites. This habitat will be lost for the duration of the Project. However, vegetation cover maintaining on the ROW will be suitable summer foraging habitat. The ROW will also likely be attractive to Porcupine in the spring when early emerging vegetation is present.

The presence of the ROW will result in the fragmentation of forested habitats. Porcupine will venture into open habitats to take advantage of high quality food sources, but these locations are more vulnerable to predators (Sweitzer 1996). Therefore, porcupine may be reluctant to cross the ROW, particularly during the winter months when the ROW does not provide food. However, the ROW will not prevent porcupine from moving between patches of primary forest habitat. Leaving vegetated buffers along watercourses is predicted to provide more secure crossing points for porcupine along the ROW.

Change in Abundance: Direct Mortality

Porcupine are slow moving, have poor eyesight and are most active at night. They are also attracted by emerging vegetation along roadsides in the spring (Schmelzer and Fenske n.d.). As such, they are vulnerable to vehicle collisions. Project Construction could result in increases in the availability of emergent vegetation in cleared areas, which could benefit individual Porcupines along the ROW but also increase the risk of collisions. The adherence to appropriate speed limits along access roads and the ROW will help to minimize the potential for porcupine-vehicle collisions.

Change in Abundance: Indirect Mortality

Roads and linear facilities provide increased access for hunters / trappers and predators, which may result in increased mortality. To mitigate this potential effect, access control measures will be developed to manage public OHV use of Project roads and trails. As well, Project personnel will not be permitted to possess firearms on-site, and Nalcor will enforce a ‘no-harvesting’ policy during working hours to limit potential effects on Porcupine abundance. Indirect mortality could also result from displacement, as movement into sub-optimal habitats and crowding could lead to increased predation and detrimental competition for food and shelter resources. However, this effect will be limited due to the fact that porcupine are tolerant of human activities. In addition, exposure to spills and / or leaks where equipment would be operating is unlikely given that

Porcupine would be at least temporarily displaced from such areas. Furthermore, mitigation measures will be in place to both limit opportunities for such an event to occur and to limit the temporal and spatial extent of any spill or leak that does occur.

Disturbance

Construction activities could result in the displacement of Porcupine from suitable habitat at or near work sites. This effect will likely be minimal as Porcupine are tolerant of anthropogenic activities. In most instances, Porcupine will shift their distribution a short distance from disturbing stimuli and will return to the habitat once the stimuli end. Areas with prolonged activity levels, such as camps, staging areas and marshalling yards, could exclude Porcupine from suitable habitat for the duration of their use. As this species generally habituates to non-threatening anthropogenic activities, the effect of this disturbance is likely negligible.

Porcupine are largely nocturnal and so interactions with Construction activities will be reduced. Training of personnel in regards to wildlife encounters will help personnel avoid or minimize disturbance to wildlife such as Porcupine. Equipment used on-site will be inspected regularly to ensure that mufflers are in good working order to minimize auditory disturbance.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Porcupine in Central and Southeastern Labrador are as follows:

- Adverse, because there is an alteration or loss of habitat. Porcupine that must relocate to new areas will be exposed to new risks from predation, vehicle collisions, and trapping. Project activities may result in changes in distribution of individuals, with subsequent increases in competition if home ranges are forced to overlap.
- Low magnitude, because habitat alteration or loss is expected to affect less than 1% of the primary habitat available within the RSA, and the number of individuals likely affected will be low due to the low population density of porcupines in Labrador. As a result, the Project will likely have little, if any, effect on the regional Porcupine population.
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA.
- Disturbance-related Construction effects will likely to be short-term and restricted to Construction activity periods. Removal of habitat along the ROW will persist for the far future, as vegetation along the ROW must be kept short and will likely be comprised of deciduous and grass species for the life of the Project. The effects of vegetation alteration or loss will be medium-term for temporary access roads, construction camps, and storage and laydown areas, as these will be allowed to return to a pre-Construction condition following the completion of Project Construction. Habitat on the ROW will likely regenerate to a condition where Porcupine will forage, but mortality rates may increase during Construction due to increased access for hunters and vehicle collisions.

There is a high degree of confidence that the effect on Porcupine will not be greater than predicted. this confidence is based on the information available on the existing environment and on the knowledge of the effects expected from similar activities. A conservative approach was taken for the assessment, which assumed that Porcupine are present throughout the LSA in habitat crossed by the ROW (including the 20% contingency), and that they will not leave the immediate area at the start of construction. The mitigation measures proposed by Nalcor to limit adverse effects to habitat and disturbance to animals are likely to limit effects on Porcupine in Labrador.

12.4.5.6 Construction Effects – Beaver

Beaver are common throughout the province, but require particular site conditions for colony establishment (i.e., an abundance of alder / aspen trees, and wetlands or waterbodies that are slow moving). Loss of habitat through vegetation removal is the most relevant effect of Project Construction on Beaver due to associated changes in the availability of trees for feeding and dam building. Direct mortality through vehicle collisions, as well as indirect mortality through exposure to hydrocarbons (i.e., accidental spills) and increased trapping due to increased access, may also influence Beaver populations along the ROW. Beavers are slow moving on land and are susceptible to collisions with automobiles when they forage on land at night. As Beaver are abundant in wetland habitats throughout the province, predicted potential effects to Beaver are expected to be similar across all geographic regions.

Construction of access roads and trails, as well as quarrying and borrowing to obtain material will involve felling trees and vegetation clearing. Waterbodies will be spanned where possible where they are crossed by the transmission line. Therefore, effects to waterways will be restricted to construction of culverts, bridges, and fords for access roads and trails during the Construction period.

Habitat will be altered or lost, and sensory disturbance from human activity may also reduce habitat availability. However, beaver are relatively tolerant of anthropogenic activities and are unlikely to abandon habitat near the ROW unless there is an area of prolonged disturbance (e.g., a construction camp or marshalling yard) in close proximity to the Beaver colony. Short-term disturbance is unlikely to result in Beaver abandoning their colonies. Beaver are largely nocturnal and tend to be active when humans are inactive, which will lessen the exposure of Beaver to sensory disturbance. Beaver are least susceptible to disturbance during the winter months when they are largely restricted to their lodges. They are more susceptible to disturbance during the ice free months when they forage on land. Beaver readily accept anthropogenic structures such as road beds and culverts that can be used to establish or expand ponds. In this regard, they can become a nuisance by flooding roads, weakening road beds or felling trees over access roads and it may be necessary to live-trap and relocate them.

Aspen is a preferred food of beaver, but is uncommon in Newfoundland and Labrador. Due to the paucity of aspen, alder is one of the most important Beaver foods in the province. The distribution of alder patches large enough to provide sufficient food for a Beaver colony can be an important factor determining the distribution and success of Beaver colonies. The removal of large areas of alder during clearing for the ROW or other construction-related facilities could potentially jeopardize a Beaver colony by affecting its main food source. The removal of Beaver dams to address flooding of access roads could also adversely affect Beavers because a deep pond is required to store the winter food supply of branches and to provide escape cover from large terrestrial carnivores such as wolves or coyotes.

Construction of the converter stations and the electrode lines may have a potential effect on Beaver, as small amounts of habitat may be affected and potential disturbance during typical Construction activities may affect Beavers near the site, if present. Disturbances similar to that for construction of the ROW may occur during Island system upgrades, as personnel will be present on-site, and small amounts of vegetation removal may be required within the existing ROWs. Marine works are not anticipated to have any effect on Beaver.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Beaver may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited, the proposed mitigation is expected to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not expected to have a measurable effect on Beaver.

Amount of Primary Habitat Altered / Available

Reducing, altering or fragmenting primary (and to some degree, secondary) habitat could affect the abundance of Beaver. Beaver sightings were restricted to wetlands in both Newfoundland and Labrador during 2008 baseline surveys (Stantec 2010e). Beaver preferentially feed on aspen, alder and willow, but can rely on conifers if deciduous species are not available (Allen 1983). Primary habitat for colony establishment may be affected by Project activities such as clearing and the construction of camps, access roads, culverts and bridges. The removal of deciduous trees and shrubs may also affect food sources for Beaver.

Primary habitat could not be mapped for Beaver at the scale considered for this Project because they have specific, small scale habitat requirements. Riparian habitat is not reflected in the ELC (Stantec 2010b, c), as the typically narrow riparian habitats could not be represented at the scale of the mapping; the assessment considered the limited disturbance to riparian buffers to address this. The most important aspects of Beaver habitat are within these riparian zones, including sources of water for ponds and food sources in the form of deciduous trees and shrubs and aquatic plants. Wetland habitats can also supply these requirements, and beaver create wetland habitat through their activities.

The effects of the Project on wetland and riparian habitat within the LSA were assessed in the Vegetation VEC (Section 12.2.5). All wetland types that are likely to be affected by the Project (i.e., that occur in the ROW) also occur elsewhere in the LSA. The proportion of each individual wetland type with the potential for Project effects was estimated at 10% or less of the total occurrence of that type in the LSA (Table 12.2.5-8). This is a conservative estimate as it assumes a centre line ROW plus a 20% contingency, and does not consider mitigation which includes routing of the final ROW to avoid wetlands where possible. In addition, little of the wetland habitat present within the ROW would be suitable habitat for Beaver due primarily to seasonal fluctuations in water level (Novak 1987; Allen 1983).

With respect to riparian habitat, the total proportion of shoreline potentially affected by the Project (including the 20% contingency) is 6% of the total riparian shoreline in the LSA (Table 12.2.5-9). By class and administrative unit, the amount of shorelines affected range from 0% of the PPWSA intake area shoreline on the Avalon Peninsula, to 11% of the PPWSA brook shoreline on the Northern Peninsula. This is considered a conservative estimate as it is based on the centre line ROW plus 20% contingency, and does not consider mitigation in place to limit vegetation disturbance at riparian crossings and the establishment of buffer zones near waterbodies. In addition, only a small proportion of riparian habitat within the LSA is suitable for Beaver occupancy.

Removal of deciduous trees and shrubs in close proximity to Beaver colonies could be detrimental because the bark of these species is an important winter food source for the species. Debarked branches are also used as building material for the lodge and dams, although less nutritious and more abundant species such as spruce can also be used for this role. Beaver colonies are typically in close proximity to these uncommon food sources and the loss of deciduous stands could result in decreased health or even mortality through starvation during the winter months. Hardwood vegetation within 30 m of a waterbody occupied by beaver will not be cleared, unless required for electrical line clearance. This buffer will reduce the potential effect of vegetation removal along the ROW or near other Project components.

Change in Abundance: Direct Mortality

Individual Beaver could be killed by collisions with vehicles or other equipment. Nalcor has a policy to allow aquatic mammals to leave the site on their own prior to blasting, thus avoiding adverse effects of this practice on Beaver. As discussed earlier, Beaver are vulnerable to collisions with automobiles because they move slowly on land and are active at night when visibility is reduced. The adherence to appropriate speed limits on access roads (i.e., 50 km/h or less) will reduce the incidence of road kill.

Change in Abundance: Indirect Mortality

Roads and linear facilities provide increased access for hunters / trappers and predators, which may result in increased mortality rates for Beaver. As with Marten and Red Fox, this potential issue will continue during Operations and Maintenance. To mitigate this potential effect, access control measures will be developed to manage public OHV use of Project roads and trails. As well, Project personnel will not be permitted to possess firearms on-site, and Nalcor will enforce a 'no-harvesting' policy during working hours so that there will be no effect on beaver abundance during the Construction phase as a result of hunting / trapping by Project staff or contractors.

Indirect mortality can be attributed to avoidance of primary habitat, exposure to greater predation and harvesting risk, as well as the desertion of lodges and young during the Construction phase due to disturbance and human activity. Sensory disturbance may lead to individual stress, which may lead to increased incidence of disease or mortality. However, given the general tolerance of Beaver to anthropogenic activities, it is unlikely that beaver will be displaced from primary habitat by the Project. It may be necessary to live-trap and relocate beavers that cause flooding of access roads (i.e., where they block culverts). If Beaver must be removed, they will be removed in accordance with the appropriate regulations and guidelines.

Payne (1982) recorded a density of 0.14 beavers/km^2 at New World Island and New Harbour in Newfoundland. Based on this density, a rough estimate of the number of Beaver potentially exposed to habitat loss can be calculated by multiplying this density by the area lost to ROW construction (i.e., 79 km^2 including 20% contingency). This yields an estimate of 11 Beaver exposed to direct habitat loss as a result of the Project. In 2006, 2,633 Beaver pelts were sold at auction in Newfoundland and Labrador. The estimate of 11 Beavers exposed to direct habitat loss represents 0.4% of the number of Beavers trapped each year in Newfoundland and Labrador.

Exposure to spills and / or leaks where equipment would be operating is unlikely given that areas where Beaver occur are unlikely to be accessed. Furthermore, mitigation measures will be in place to both limit opportunities for such an event to occur and to limit temporal and spatial extent if a spill or leak did occur. Considering the mitigation in place few, if any, direct or indirect incidents of mortality of Beaver are expected.

Disturbance

Construction activities typically involve the presence of numerous workers, vehicles, and equipment on-site during regular working hours. There is the potential for disruption to individual Beaver during this phase due to noise, dust, and light disturbance. Noise effects would be the most common and most prevalent, as they are further reaching. There is also a risk of disruption to denning / mating / rearing areas, and potential unintentional harassment of individuals by construction crews.

Construction activities are not likely to result in disturbance to large numbers of beaver. Some disturbance could occur in areas where human activities are conducted over long periods of time, such as construction camps or marshalling yards, but only if there are Beaver located in the vicinity.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Beaver will be similar in wetland and riparian habitats across the province, and are as follows:

- Adverse, because there is an alteration or loss of habitat for Beaver. Mortality rates may increase during Construction due to increased access for trappers and vehicle collisions. There is the potential that disturbed sites that are located close to suitable water sources will be colonized by alder or willow thickets which could provide food sources for Beaver.
- Low magnitude, because the amount of habitat (wetland and riparian) affected is predicted to be less than 1% of the RSA once mitigation is implemented. Few Beaver, if any are likely to be killed during

Construction activities following implementation of mitigation measures. As a result, the Project is likely to have little, if any, effect on regional Beaver populations.

- Limited to the RSA, as physical disturbance of habitat will be limited to LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA.
- Disturbance-related Construction effects are anticipated to be medium-term and restricted to active Construction periods. Alteration or loss of habitat along the ROW and access roads required for Operations and Maintenance will persist into the far future, as vegetation along the ROW must be kept short and will likely be comprised of deciduous and grass species for the life of the Project. Effects of vegetation alteration or loss will be medium-term for temporary access roads, construction camps, and storage and laydown areas, as these will be decommissioned and allowed to return to a pre-Construction condition following Project completion.

There is a high degree of confidence that the likely effect on Beaver will not be greater than predicted. This confidence is based on the information available on the existing environment and knowledge of effects from similar activities. A conservative approach was taken throughout the assessment, which assumed there are beaver present throughout the LSA in suitable habitat. Conservative approaches were also applied to the estimation of the amount of riparian and wetland habitat likely to be affected by the Project. The mitigation measures committed to by Nalcor to limit adverse effects to habitat and disturbance of animals are likely to limit effects on Beaver.

12.4.6 Operations and Maintenance

12.4.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

The relevant activities for Furbearers associated with Operations and Maintenance are the safety inspections, conducted either from the ground or from the air, and vegetation management to maintain the safe operating condition of the transmission line. Repairs would also be completed as required, pending the results of the inspections or to address unexpected accidents or malfunctions (e.g. major system repairs). As such, the effects would be related primarily to disturbance due to human activity and equipment use, as well as limited disturbance to regenerating vegetation within the ROW, depending on the type of maintenance or repair required. If major system repairs are required, the effects would be similar to those described for construction, with the same mitigation applied. The extent of the disturbance would depend on the extent of the repairs required.

While vegetation management activities will occur within the ROW during Operations and Maintenance, this will occur in areas already cleared during Construction. Furbearers will be exposed to occasional disruption and disturbance due to clearing and other inspection and maintenance activities, but it will be less than during Construction, as activities will be periodic and less intensive. Vegetation maintenance will likely occur at seven year intervals, beginning in year 8 following Construction, or as required for safety, and will involve herbicide applications. The herbicide Tordon 101 (with Sylgard 309 as a surfactant) will be applied by qualified, trained personnel in a careful manner, following the manufacturers' instructions and in accordance with the applicable regulations. OHV access by the public along the ROW will likely be an issue throughout the Operations and Maintenance Phase of the Project. To mitigate this potential effect, access control measures will be developed to manage public OHV use of the ROW and Project roads and trails, for both the Construction and Operations and Maintenance phases of the Project.

Nalcor has standard mitigation measures for transmission Operations and Maintenance throughout the province. Mitigation measures identified in the Vegetation VEC (Section 12.2.5) that are relevant to vegetation distribution and abundance, wetlands and riparian shoreline would also be effective in minimizing effects on furbearers, particularly measures related to managing increased OHV access. Relevant vegetation mitigation measures, as well as mitigation directly related to furbearers include:

- Nalcor will modify the vegetation management program to maintain the habitat connectivity created during construction in core Marten areas in Newfoundland, if necessary.
- Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002.
- Ground travel within the ROW for inspection or maintenance of the transmission line will be restricted to existing and / or approved trails. These trails will be used and maintained in accordance with the applicable regulations.
- Upon completion of the Construction phase, temporary access will be assessed to determine if it will be needed for Operations and Maintenance; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the condition of the road or trail.
- Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally.
- Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of riparian shoreline(s) will include regular inspection and maintenance of those structures.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.
- Vegetation buffer zones, established at environmentally sensitive areas during Construction, will be maintained. Only danger trees will be removed from these areas.
- Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied as applicable and will be described in the EPP.
- Transmission line maintenance and repair personnel will adhere to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions.
- Transmission line maintenance and repair personnel will not feed or harass wildlife.
- Nalcor personnel and contractors will not interfere with traplines or associated equipment.
- Only essential vehicular activity, including helicopter flights, will be permitted along the transmission line ROW to minimize disturbance to wildlife.
- Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task, and any inspections, maintenance and / or repairs will be completed as quickly and efficiently as safety allows.
- Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products.
- Well maintained equipment with quality mufflers will be used and equipment maintenance schedules will be followed.
- Engine idling will be minimized and environmental awareness training with key personnel will be conducted on this topic.

In addition, as necessary, a modified vegetation maintenance program will be implemented to limit the effects of fragmentation of Marten core habitat in Newfoundland as a result of Project Construction. This is discussed in further detail below.

12.4.6.2 Existing Knowledge

There are a number of studies and reviews documenting the effects of Operations and Maintenance practices on mammals. Those that are directly applicable to the Furbearer KIs are summarized in Table 12.4.6-1.

Table 12.4.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Furbearers

Reference	Study / Project Context	Summary of Findings
Benítez-López et al. (2009)	– A meta-analytical review of international literature on the decline of mammal and bird populations in the proximity of a variety of road types and other infrastructure	– Infrastructure and associated activity represent an important factor in biodiversity loss – The most common effects are habitat loss, intrusion of edge effects in natural areas, isolation of populations, barrier effects, road mortality and increased human access – Road construction leads to habitat destruction and creates open spaces in otherwise closed forests that may fragment populations, serve as corridors for the spread of invasive species, attract light-demanding or predator species, and may be avoided by others – The use of infrastructure by cars or trains increases the risk of collisions with wildlife and stress on (breeding) individuals due to sensory disturbance, which could affect reproductive success and population maintenance – Reductions in mammal populations have been found at distances of a few hundred metres up to approximately 5 km with variations according to taxa and habitat – Population densities significantly declined with increasing proximity to infrastructure – The abundance of small-sized mammals were affected within a few metres of infrastructure, while the abundance of large-sized mammals was reduced up to several hundred metres – Populations are displaced from infrastructure, and that displacement distance depends on the habitat type and the species – Rodent populations were slightly affected within a few metres from infrastructure

Table 12.4.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
Underhill and Agnold (2000)	– Examination of the effects of roads on wildlife in an modified landscape in the UK	– Literature commonly cites a disturbed or polluted zone up to 5 m from the road, and a detectable effect up to 100 m from a road in the UK – Roads resulted in a direct loss of habitat, increased ratio of edge to habitat, reduction in patch size, and isolation of remnant habitat effects of roads was due to pollutants, noise, mortality, and barriers or fragmentation to movement – If new construction fragments an area in such a way as to leave habitat 'islands' distant, disconnected, and smaller, then the remaining populations may not be able to recover – The natural inclination of small mammals was to avoid crossing roads and to adopt roads as boundaries to their normal home range – Population effects of road fatalities appeared generally at the local level where there are small populations, or for endangered (e.g., listed) species – For most species, road kills did not seem to have a significant effect at the population – The mortality rate combined with the barrier effect of roads may become of increasing significance in a patchy and fragmented landscape – Roads frequently cross environmental and topographical contours (unlike 'natural' corridors) and can link a range of different habitats, thus facilitating biotic movement through an otherwise unsuitable landscape
Simon et al. (1999a)	– Examination of the effects of trapper access on marten populations in central Labrador	– Marten in easily accessible areas were harvested more intensively and were maintained by recruitment of dispersed juveniles from less accessible areas – In areas with extensive road networks, age and sex ratios indicated that marten in Labrador have been over-harvested. Comparatively, areas with minimal access do not experience over harvesting

Table 12.4.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
Berger (1995)	– General overview of the positive and negative effects of transmission lines in Manitoba (prepared by Manitoba Hydro) (Operations and Maintenance)	– Line maintenance activities, including regular inspection, repair of the line, and management of vegetation along a ROW can affect animals – Effects on wildlife from noise and presence of workers is infrequent and minor – Vegetation management affects wildlife habitat by changing the plant community. Effects are less than during construction and may be beneficial, improving habitat and resulting in a greater diversity of wildlife species – Herbicides allow grasses, sedges, ferns, and a few herbicide-resistant herbs and woody plants to form the major community along ROWs. These provide cover and food for small mammals – Small mammals and rodents (including hare) fed more often in the ROW than in the adjacent forest areas – More browse was available for some species along ROWs than in adjacent forests – ROW clearing resulted in a mixture of habitats, allowing greater numbers and kinds of wildlife to be present. New edge stimulates the growth of grasses and shrubs – Edges may result in vegetation species composition changes as invasive edge species appear, further reducing the remaining habitat available for edge intolerant species – If the original landscape has already been fragmented by other activities such as forestry or agriculture, an individual transmission line usually does not increase habitat fragmentation – Physical presence of a ROW can create better wildlife habitat – the number and kinds of animals along a ROW often remain the same or increase in response to the exposure to the sun and new mixture of habitats – ROWs may displace or impede movements of mammals that inhabit small territories or home ranges in mature forest stands – Some aquatic furbearing mammals (e.g., beaver, muskrat) will not be affected at all by winter ROW and transmission line construction as long as bank dens, lodges and push-up areas are not damaged. Terrestrial furbearing mammals will be displaced during construction but usually return after this activity is completed – Narrow linear clearings did not act as barriers to movements of wide-ranging species, such as wolves – Species that inhabit or use shrublands, forest regeneration areas, or old burns will likely take advantage of ROWs – Herbivores frequently feed and travel on ROWs, attracting carnivores such as wolf, lynx, and red fox – During winter, a ROW may create a tunnelling effect when it passes through dense forest, and snow accumulates. Snow-drifting can have negative implications on the movements of animals, but may also create better thermal cover for small mammals that tunnel and burrow under the snow

Table 12.4.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Furbearers (continued)

Reference	Study / Project Context	Summary of Findings
		– ROWs provide increased ease of winter access to trappers and subsequent mortality effects on wildlife – Edge effects provide new habitat for hares and small mammals, which in turn will attract furbearers and improve the potential for increased production of wildlife – Unfamiliar noise during maintenance may cause furbearers to be displaced temporarily until the infrequent and short-term activity has been completed
Deichmann (1990)	– Examination of effects of snow vehicles in Gros Morne National Park, western Newfoundland	– The negative effects of snow vehicles on small mammals included the compaction of burrows and a less adaptable micro-climate due to compaction-induced temperature differentials – Snowshoe hare avoided areas with trails, while red fox used trails as travel corridors
Oxley et al. (1974)	– Studies the effects of roads on populations of small mammals in Ontario and Quebec	– Roads facilitate access to food, but may lead to damaging or fatal accidents – A small number of small mammals crossed roads, but typically only those 30 m or less – several factors inhibit crossings, including traffic, road surface, and clearance – Medium-sized mammals showed increasing mortality rates with increasing road clearance (crossing distance) – In all cases, road mortality rates were highest in July, corresponding to high traffic levels and the emergence of the young of several species – Traffic, light intensity, and road surface did not inhibit road crossings, while ROW width was a determining factor – Divided highways with widths of 90 m or more may act as effective barriers to the dispersal of small mammals, as with bodies of fresh water twice as wide – If large gene pools are important to the survival of populations of animals living under 'harsh' environmental conditions, roadways have important effects on these populations due to the potential fragmentation of gene pools

12.4.6.3 Operations and Maintenance Effects - Furbearers

Activities that would affect Furbearers during Operations and Maintenance include routine line inspections and repairs, vegetation management, and system repairs. The primary effect would be disturbance by vehicles (e.g., ATVs or helicopters) and human activity, as well as habitat alteration during vegetation management and system repairs.

Transmission line inspections will be conducted annually, on a rotational basis, with portions of the line scheduled for inspection each year. Inspections of the on-land transmission line may be completed from the air or from the ground. Ground-based inspections will be conducted using ATVs during summer and snowmobiles in the winter, and aerial inspections will be conducted by helicopter. Typical transmission line maintenance activities include minor adjustments and replacements (e.g., replacement of insulators). However, more extensive repairs may be required that could involve the replacement of anchors or guy wires, necessitating the use of heavy equipment such as backhoes or cranes. More extensive repairs would therefore result in disturbance due to vehicle operation and human presence, as well as small areas of habitat alteration.

Vegetation management (i.e., herbicide application and manual cutting) will continue over the life of the Project and will be the primary interaction with Furbearers in the area and will likely occur every seven years. Vegetation management will involve equipment movement and human presence within the sections of the ROW being addressed (i.e., forested areas), and will result in limited habitat alteration and disturbance.

Other factors influencing Furbearers during this phase are: the continued potential for mortality through vehicle collisions, although the potential is reduced due to fewer vehicles and reduced road access after rehabilitation; exposure to chemicals (e.g., herbicides); and increased risk of predation and hunting / trapping due to increased access. For most Furbearers, potential effects are geographically limited, and a relatively small number of individuals would be disturbed. Therefore, population-level effects on are not expected.

Accidents and malfunctions could occur during Operations and Maintenance, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, multiple tower failure, localized slope failure, waste spill) on Furbearers may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited, the proposed mitigation is expected to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not likely to have a measurable effect on Furbearers.

Because the potential effects during Operations and Maintenance are minimal and similar for all Furbearers, they will be discussed together in one section.

Amount of Primary Habitat Altered / Available

Vegetation alteration or loss during Operations and Maintenance will be on a much smaller scale than that altered or lost during construction. Effects will be restricted to the access and ROW because the temporary access roads, camps, and other construction areas will be decommissioned and allowed to regenerate following construction. Vegetation that exceeds 2 m in height at maturity will be removed to prevent trees from growing into, and possibly damaging, the lines. Some brush clearing of regenerated vegetation may occur to allow Nalcor to maintain a small number of access roads or trails, but the effects will be limited in terms of habitat loss. Where system repairs are required, the alteration or loss of regenerating vegetation within the ROW is expected to be limited to a small area near the base of a tower or at an anchor point.

No additional loss of habitat is predicted for the Operations and Maintenance Phase, and only alteration of regenerating vegetation will occur to maintain a dense plant cover that discourages the invasion of nuisance vegetation (i.e., vegetation that exceeds 2 m in height at maturity) while encouraging the growth of Project compatible vegetation (i.e., vegetation less than 2 m in height at maturity). As vegetation within the ROW will regenerate, it is likely that there will be some cover for Furbearers to cross the ROW, particularly where forested habitat types are crossed. Marten typically do not forage in open habitat and are reluctant to cross large openings, so maintenance of the ROW as open habitat contributes to fragmentation of Marten habitat. In a largely undisturbed region, such as Central and Southeastern Labrador, the effect of the ROW on Marten distribution and abundance is expected to be minimal, as large patches of contiguous primary habitat are plentiful on either side of the ROW. In Newfoundland, where the habitat is already fragmented by young clear-cuts, the presence of vegetated buffers along watercourses would provide corridors that would provide Marten passage from one side of the ROW to the other.

It may be practical to create additional larger corridors and better functioning vegetation cover within portions of the ROW by altering the vegetation maintenance program along portions of the ROW that pass through areas of Marten core habitat in Newfoundland. Normally, vegetation management is conducted in long (i.e., tens or even hundreds of kilometres long) sections of the ROW. However, much smaller patches of vegetation would be treated and the rotation period would be longer in the modified vegetation maintenance program. The goal would be to develop a dense shrub and tree cover dominated by coniferous species that provides sufficient overhead and lateral cover to facilitate Marten and other Furbearer species movement. Vegetation would be maintained low enough to prevent interference with overhead lines and could be travelled through by tracked vehicles in the event of required repairs or an emergency. When the vegetation approaches a height of approximately 6 m, the patch would be cut and an adjacent uncut patch would provide access across the ROW. The sizes of these patches would be smaller than the average home range size for Marten to minimize the likelihood that individuals would be isolated when a particular patch is cleared. Ideally, the patches would be partially cleared with smaller trees left in place to hasten the development of overhead cover. Although this mitigation is not required to determine the effects on Marten in this EA, this approach will be discussed with the NLDEC Wildlife Division.

Prey Availability

The plant community will remain altered along the ROW for the life of the Project, as vegetation management will occur every seven years. These activities may improve habitat, resulting in a greater diversity of wildlife that are attracted to grasses and edge habitats. Berger (1995) noted that small mammals feed more often in the ROW than in the adjacent forested areas. Maintenance activities could therefore result in the establishment of large populations of small mammals on the ROW. Most mammalian carnivores will not be deterred by the presence of the ROW and can be expected to exploit small mammal populations on the ROW. Red fox and coyote in particular can be expected to regularly forage on the ROW. Marten, however, may not exploit this food source if there is insufficient cover, although they may forage along the edges of the ROW (Hargis et al. 1999). The establishment of slash piles along the ROW during the Construction phase will also help mitigate this avoidance.

Change in Abundance: Direct Mortality

There is the potential for Furbearers to be struck by vehicles or to come into contact with herbicide. Adherence to appropriate speed limits applicable to the size and class of the access roads, and awareness of construction crews to be vigilant, will limit the potential for vehicle-wildlife collisions. Vehicles travelling on the ROW will likely go slowly enough that any interactions with furbearers are avoided.

The application of herbicide products is a highly regulated activity. Nalcor will meet or exceed the requirements of the application regulations. Further, the herbicide to be used, Tordon 101, is non-toxic to wildlife. Also, the herbicide surfactant to be used, Sylgard 309, is typically used at relatively low rates and is not expected to be harmful to wildlife. Therefore, the likely effects of herbicide application on Furbearers and other wildlife using the ROW are negligable.

Spills and leaks near drainages or wetlands supporting beaver could result in health effects to beaver (e.g., reducing thermal properties of their coat, ingestion causing nausea). However, with the Nalcor requirement to keep equipment clean and in good operating condition, and with spill response kits on equipment as appropriate, mortality to Beaver resulting from spills is not predicted.

Direct mortality due to the Project during Operations and Maintenance is therefore not likely to have an effect on the abundance of Furbearers.

Change in Abundance: Indirect Mortality

Roads and the ROW will continue to provide increased access and subsequent increased risk of hunting / trapping. This is particularly relevant for Marten and for Porcupine, as both of these species can be easily overexploited in areas of easy access (Schmelzer and Fenske n.d.; Simon et al. 1999; Chapin et al. 1998). This risk will be reduced through the decommissioning of the temporary access roads and trails and the development of access control measures to manage public OHV use of Project roads and trails.

The effects of Project Operations and Maintenance on Furbearers are generally common across the province. However, Marten in Newfoundland are sensitive to habitat change and are considered a species of special conservation concern, and Porcupine are exclusive to Labrador.

Summary of Likely Residual Environmental Effects

The overall likely residual effects of Project Operations and Maintenance on Furbearers are as follows:

- Adverse, because there will be a change to the type and amount of regenerating habitat present following routine maintenance, and there will be sensory disturbance to Furbearers.
- Low magnitude, because habitat alteration or loss is predicted to affect a small portion of previously disturbed habitat and have no measurable effect on populations. Prey species for Marten and Red Fox are likely to return to the area after Construction and following routine maintenance activities.
- Limited to the RSA, as physical disturbance of habitat will be limited to LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA and noise and associated disturbance will extend into the RSA.
- Will be evident into the far future, as Operations and Maintenance activities will continue over the life of the Project. The discontinuous nature of activities over this period reduces the overall effect on Furbearer habitat and populations.

There is a high degree of confidence that the likely effect on Furbearers will not be greater than predicted. This confidence is based on the knowledge of the existing environment and of the effects observed from similar activities. A conservative approach was taken throughout the assessment, which assumes that Furbearers are present throughout the area and that they will not leave the immediate area during Operations and Maintenance.

12.4.7 Environmental Effects Summary and Evaluation of Significance

12.4.7.1 Summary of Environmental Effects

The assessment of the likely effects of Project Operations and Maintenance on Furbearers considered all aspects of Furbearer ecology in the province, as well as the likely effects on Furbearers from Project Construction and Operations and Maintenance following the application of mitigation measures. The likely effects of Construction and Operations and Maintenance on each KI are summarized below in Table 12.4.7-1.

Table 12.4.7-1 Environmental Effects Analysis Summary: Furbearers

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Marten	**Adverse** – There will be a reduction in primary habitat along the ROW and a fragmentation of Marten habitat. Habitat loss and fragmentation would be of most concern in Newfoundland. – Disturbance of some individuals will occur due to increased human activity. – Increased access to Marten habitat will result in increased trapping pressure in Labrador.	**Low** – <1% of primary habitat present within the RSA will be affected in Labrador. – In Newfoundland, 0.1% of habitat will be affected in the Main River core area and 0.01% of habitat will be affected in the Terra Nova core area. – Effects are not expected to jeopardize the sustainability of individual populations.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance will likely to extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Effects from clearing will occur throughout the Construction period; effects from on-site equipment will occur periodically during the construction period.
Red Fox	**Adverse** – There will be a loss of habitat, although the regeneration of vegetation on the ROW will create new habitat. – Habitat fragmentation is unlikely to be an issue. – Increased trapping pressure caused by greater access is likely to occur but is unlikely to have an adverse effect at the regional level.	**Low** – Habitat alteration or loss will be minimal, and, while individuals may be affected, this is not likely to jeopardize the sustainability of individual populations. – The removal of potential habitat is not limiting because foxes will quickly move and adapt to available habitat.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance will likely extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Effects from clearing will occur throughout the Construction period; effects from on-site equipment will occur periodically during the Construction period.

Table 12.4.7-1 Environmental Effects Analysis Summary: Furbearers (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Porcupine	**Adverse** – Habitat, particularly winter feeding habitat and summer roosting habitat, will be lost. – Regrowth of vegetation on the ROW will result in the development of summer feeding habitat. – Porcupine mortality could increase as a result of road kill and increased access to the area by hunters.	**Low** – Habitat alteration or loss will likely affect <1% of the primary habitat available within the RSA. – The number of individuals likely affected will be low due to the low population density of Porcupines in Labrador. – The Project is likely to have little if any effect on the regional Porcupine population.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance likely extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Effects from clearing will occur throughout the Construction period; effects from on-site equipment will occur periodically during the Construction period.
Beaver	**Adverse** – Habitat loss may occur but will be limited due to the protection afforded to riparian habitats. – Habitat fragmentation is not likely to have any serious effects on beaver. – Beavers are relatively tolerant of human activities and are unlikely to be seriously affected by disturbance. – Beavers are vulnerable to road kill and greater access could lead to increased mortality.	**Low** – The amount of habitat (wetland and riparian) affected will likely be <1% of the RSA once mitigation is implemented. – Few beaver, if any are likely to be killed during Construction activities following implementation of mitigation measures. – The Project is likely to have little if any effect on regional Beaver populations.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance will likely to extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Effects from clearing will occur throughout the Construction period; effects from on-site equipment will occur periodically during the Construction period.

Table 12.4.7-1 Environmental Effects Analysis Summary: Furbearers (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Summary of Likely Residual Construction Effects on Furbearers: The amount of Furbearer habitat altered or lost to access and ROW construction is likely to have limited effects on Furbearer populations at the regional level, considering specific mitigation designed for Marten and the regenerating vegetation within the ROW. Disturbance associated with Construction activities may displace individual animals for the short to medium-term, depending on the activity type, but the regional distribution of Furbearers is not likely to be affected. Any increase in trapping and hunting pressure is not likely to affect populations at the regional level.					
Operations and Maintenance					
Marten	**Adverse** – Although no additional loss of habitat will occur, the open habitat on the ROW will be maintained for the duration of the Project. – In high priority areas such as Marten core areas in Newfoundland, it may be possible to increase connectivity between habitats on either side of the ROW by modifying the vegetation maintenance program. – The increased access provided by the ROW will increase the potential for disturbance of Marten. – In Labrador, increased access will result in increased trapping pressure.	**Low** – Habitat modification caused by vegetation maintenance will have little effect on the availability of Marten habitat since the ROW will not be used extensively by Marten, and will have no measurable effects on populations. – Modifications to ROW clearing and vegetation maintenance in the Main River core area could increase Marten use of the ROW and connectivity between habitats on either side of the ROW. – In areas of the ROW where conventional vegetation management is practiced, Marten will not forage frequently on the ROW so changes in prey availability associated with vegetation maintenance are likely to have	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Operations and Maintenance will continue for the life of the Project.	– Annual inspections and vegetation management along the line will occur, but activities in any one area are infrequent (e.g., every five to seven years).

Table 12.4.7-1 Environmental Effects Analysis Summary: Furbearers (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
		negligible effects on local Marten populations. – Modified vegetation management practices may permit Marten to forage in parts of the ROW. – Disturbance associated with maintenance activities will be infrequent and of short duration will likely have negligible effects on Marten populations.			
Red fox	**Adverse** – As Red Fox prefer semi-open habitats, vegetation maintenance is not likely to adversely affect habitat suitability for fox and may increase the amount of suitable habitat. – Red fox are relatively tolerant of human activities so maintenance activities along the ROW and at other Project related facilities are not likely to have an adverse effect on fox. – Trapping pressure could increase as a result of increased access.	**Low** – Any potential habitat removal during maintenance work will likely affect only a small portion of available habitat, and will have no measurable effects on populations. – The displacement of prey from the site will be limited and restricted to the maintenance period.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Operations and Maintenance will continue for the life of the Project.	– Annual inspections and vegetation management along the line will occur, but activities in any one area are infrequent (e.g., every five to seven years).

Table 12.4.7-1 Environmental Effects Analysis Summary: Furbearers (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Porcupine	**Adverse** – The habitat on the ROW maintained by vegetation maintenance activities will be used by Porcupine but will be less valuable than forested habitat. – Sensory disturbance due to maintenance activities along the ROW are not likely to have adverse effects on Porcupines. – The ROW could provide increased access resulting in higher hunting pressure on Porcupine.	**Low** – Any potential habitat removal during maintenance work will likely affect only a small portion of available habitat, and will have no measurable effects on populations. – Effects are not likely to jeopardize the sustainability of the population.	**Local to Regional** Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** Operations and Maintenance will continue for the life of the Project.	– Annual inspections and vegetation management along the line will occur, but activities in any one area are infrequent (e.g., every five to seven years).
Beaver	**Adverse** – Vegetation maintenance activities are not likely to have adverse effects on habitat suitability for Beaver since most high quality habitat is located in buffered riparian areas. – Beavers are relatively tolerant of human activities so maintenance activities along the ROW are unlikely to have adverse effects on Beaver.	**Low** – Any potential habitat removal during maintenance work will likely affect only a small portion of available habitat, and will have no measurable effects on populations. – Effects are not likely to jeopardize the sustainability of the population.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Operations and Maintenance will continue for the life of the Project.	– Annual inspections and vegetation management along the line will occur, but activities in any one area are infrequent (e.g., every five to seven years).

Table 12.4.7-1 Environmental Effects Analysis Summary: Furbearers (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
	– Trapping pressure will likely increase as a result of increased access.				
Summary of Likely Residual Operations and Maintenance Effects on Furbearers: Based on the nature of the proposed Project, and with the incorporation of standard mitigation, the likelihood of interactions with Furbearers during Operations and Maintenance is considered to be low, and limited to short-term disturbances on localized portions of the ROW, as well as individual animals in the vicinity. Project Operations and Maintenance is not likely to have a measurable effect on the regional distributions or populations of Furbearers.					

12.4.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. Furbearers play an important role in the natural environment, because they are top predators, keystone species, and prey species found in all ecosystems throughout the province. In addition, Furbearers contribute to provincial economics as a source of pelts for the fur industry, and some are hunted as a food source for recreational and subsistence purposes. Furbearers also feature prominently in local culture. Maintenance of populations in a sustainable fashion will allow for the continued ecological and economic role of this VEC into the future.

A significant adverse residual effect on the Furbearers VEC as a result of the Project would cause a decline in the numbers of animals such that a population cannot be maintained within the RSA or in any of the regions considered. A likely residual adverse environmental effect that does not meet the above criteria is not significant.

The amount of potential alteration or loss of primary habitat is the measurable effect of greatest importance in determining the significance of the likely Project effect on the Furbearer KIs. For all the KIs, the Project is likely to result in the alteration or loss of less than 5% of the primary habitat in the LSA.

Disturbance events (e.g., presence of human activity and equipment) are infrequent and of relatively short duration, and no long-term disturbances are likely in important or proposed critical (NLDEC 2011c) habitat areas, such as Marten core areas in Newfoundland.

Accidental mortality associated with collisions with vehicles is likely to be minimal considering the adherence to appropriate speed limits on access roads. Indirect mortality and disturbance of Furbearers are likely to be limited due to access management by Nalcor.

Considering the above, no detectable change in regional populations or impairment of the sustainability of Furbearer populations in Newfoundland and Labrador is likely to occur as a result of the Project. Therefore, the Project is not likely to result in significant adverse environmental effects on Furbearers.

12.4.8 Evaluation of Project Alternatives

A number of Project alternatives have been considered by Nalcor during the planning of the Project. These alternatives represent different route options that have been considered in response to stakeholder, environmental or engineering considerations. All Construction and Operations and Maintenance activities discussed for the preferred option would be applied to these options, in the event that they were selected. Likely effects on Furbearers for each of these alternatives, in relation to the proposed (preferred) transmission corridor, are presented in Table 12.4.8-1.

Table 12.4.8-1 Summary Evaluation of Project Alternative Means: Furbearers

Project Alternative Means	Environmental Implications (Compared to the Transmission Corridor)			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Central and Southeastern Labrador				
A2: North-west of Strait of Belle Isle Alternative Segment	– Minimal increase (1.9%) in habitat alteration or loss and associated disturbance	– Minimal increase (0.8 km^2) in habitat alteration or loss and associated disturbance	– Minimal increase (1.9 km^2) in habitat alteration or loss and associated disturbance	– Minimal increase (0.8%) in habitat alteration or loss and associated disturbance
A3: Point Amour Alternative Segment	– Minimal increase (0.8%) in habitat alteration or loss and associated disturbance	– Minimal increase (0.3 km^2) in habitat alteration or loss and associated disturbance	– Minimal increase (0.8 km^2) in habitat alteration or loss and associated disturbance	– Minimal increase (0.3%) in habitat alteration or loss and associated disturbance
Northern Peninsula				
A4: Strait of Belle Isle Newfoundland Side Alternative Segment	– No difference; no known occurrence of marten in this area	– Increase (12.8 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– increase (12.8 km^2) in habitat alteration or loss and associated disturbance
A5: Great Northern Peninsula (GNP) North-east Alternative Segment	– No difference; no known occurrence of marten in this area	– Increase (3.4 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– Increase (3.4 km^2) in habitat alteration or loss and associated disturbance
A6: GNP West-central Alternative Segment	– No difference; no known occurrence of marten in this area	– Increase (6.6 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– Increase (6.6 km^2) in habitat alteration or loss and associated disturbance
A7: GNP Eastern Long Range Mountain (LRM) Crossing Alternative Segment	– No difference; no known occurrence of marten in this area	– Minimal decrease (0.9 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– Minimal decrease (0.9 km^2) in habitat alteration or loss and associated disturbance
A7: GNP Eastern LRM Crossing Alternative Segment + A8: GNP International Appalachian Trail Newfoundland and Labrador Alternative Segment	– No difference; no known occurrence of marten in this area	– Increase (17.0 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– Increase (17.0 km^2) in habitat alteration or loss and associated disturbance

Table 12.4.8-1 Summary Evaluation of Project Alternative Means: Furbearers (continued)

Project Alternative Means	Environmental Implications (Compared to the Transmission Corridor)			
	Marten	**Red Fox**	**Porcupine**	**Beaver**
Central and Eastern Newfoundland				
A9: Birchy Lake Alternative Segment	– Implications for but still outside west-central (Little Grand Lake / Red Indian Lake) population; loss / alteration of habitat in the core area	– Increase (13.3 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– Increase (13.3 km^2) in habitat alteration or loss and associated disturbance
A10: Newfoundland and Labrador Outfitters Association Alternative Segment	– Increase in habitat alteration or loss in the core area of the west-central population	– Increase (2.6 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– Increase (2.6 km^2) in habitat alteration or loss and associated disturbance
Avalon Peninsula				
A11: Avalon Alternative Segment	– No difference; no known occurrence of marten in this area	– Decrease (0.18 km^2) in habitat alteration or loss and associated disturbance	– No difference; no Newfoundland population	– Decrease (0.18 km^2) in habitat alteration or loss and associated disturbance

12.4.9 Cumulative Environmental Effects

Cumulative effects are the overall effect on the VEC within the RSA as a result of the Project's likely residual environmental effects that overlap both temporally and geographically with those of other projects and activities. The environmental effects of past and existing projects and activities are captured in the baseline conditions for Furbearers (i.e., as presented in the existing environment chapter).

Much of the Labrador portion of the RSA remains relatively undisturbed by anthropogenic activity and Furbearer populations therein are considered to be in a "natural" state. However, the north-western portion of the RSA follows the TLH3 and is within the Low Level Training Area (LLTA) military area and would therefore be subject to fragmentation and infrequent sensory disturbance effects.

Furbearer habitats and populations within the Newfoundland segment of the RSA have been affected by anthropogenic effects to a greater extent, as evidenced by the presence of communities, cottage areas, highways, access roads, various aged cut blocks and recreational activity. However, much of the non-commercial forest landscape crossed by the Project is still in a relatively "natural" state, including large tracts of land, particularly on the Northern Peninsula. Stressors to Furbearers in Newfoundland that the Project has the potential to interact with include a diversity of infrastructure, such as that associated with transportation (e.g., the TCH, secondary and tertiary roads, forestry roads), commercial (e.g., existing transmission lines) and residential activities, as well as those related to forest management activities.

The primary environmental effect of Project Construction on Furbearers within the RSA will be through the alteration or loss of habitat required for the various Project components (e.g., access, transmission ROW). However, a number of other Project components or activities also have potential to affect Furbearers, including vegetation management, sensory disturbance, and subsequent increased OHV use and hunting or trapping pressure. Nalcor has committed to mitigation measures that will limit Project effects on Furbearers and their habitat. Overall, likely residual environmental effects to Furbearer KIs are predicted to be low in magnitude, are limited to the RSA and predicted to be not significant. It is predicted that the Project will not have a measurable effect on the regional distributions or populations of Furbearers.

Future activities that result in the clearing or disturbance of vegetation have the greatest potential to act cumulatively with the Project to affect Furbearers. These clearing activities will result in habitat alteration or loss and may create additional sources of sensory disturbance. Also, increased access for OHVs could be created, resulting in increased hunting and trapping pressure, particularly in previously inaccessible areas in close proximity to communities or existing access.

Projects and activities in Central and Southeastern Labrador with residual effects that are likely to overlap with the effects of the Project include: the Lower Churchill Hydroelectric Generation Project; the TLH3; commercial forestry activity; general economic and infrastructure development; and, other current land uses, particularly trapping, hunting and OHV use.

In the Northern Peninsula, projects and activities with residual effects that are likely to overlap with the effects of the Project include: general economic and infrastructure development; commercial forestry activity; Parson's Pond oil and gas exploration drilling; and, other land uses, particularly hunting, trapping and OHV use.

Projects and activities in Central and Eastern Newfoundland with residual effects that are likely to overlap with the effects of the Project include: general economic and infrastructure development; commercial forestry activity; and, other land uses, particularly hunting, trapping and OHV use.

On the Avalon Peninsula, projects and activities with residual effects that are likely to overlap with the effects of the Project include: general economic and infrastructure development; commercial forestry activity; and, other land uses, particularly hunting, trapping and OHV use.

Note, all other projects or activities listed in Table 9.3.9-2, are not considered in the cumulative effects assessment on Furbearers as these developments do not overlap spatially with the Project and are not in proximity to the RSA, and therefore no cumulative effects are likely.

The Project will result in clearing of vegetation for the various Project components, which is likely to act cumulatively with the clearing related to activities such as infrastructure development and forestry, resulting in habitat alteration or loss and fragmentation, where these activities overlap with the RSA. Nalcor has limited the potential for these effects by routing the transmission corridor along a portion of the TLH3 in Labrador, and in the vicinity of existing disturbance corridors within Newfoundland, to the extent feasible. It is expected that further refinement of this process will occur during the selection of the final ROW alignment. Forestry activity in the province is conducted through District-based Sustainable Forest Management Plans, and includes Five Year Operating Plans that detail the specific mitigation and management measures to minimize the potential environmental effects of these activities. This, in conjunction with forestry exhibiting a general decline on the Island of Newfoundland due to the closure of several mills in recent years, will limit the potential for cumulative effects of forestry with the Project on Furbearers.

Project activities and infrastructure may interact with existing stressors in the RSA resulting in cumulative effects on Furbearers. For example, as a result of clearings and roads created by the Project and other developments, cumulative sensory disturbances and hunting / trapping effects may occur as a result of increased OHV access. To limit the contribution to cumulative environmental effects resulting from increased access, access control measures will be developed to monitor and manage public OHV and other uses of the Project ROW, roads and trails. This will include an education component, local community involvement with active participation and support from Nalcor, and ongoing evaluation during inspections.

The effects of the Project in combination with other projects and activities that have been or will be carried out are not expected to result in an effect on Furbearers KIs that would cause a decline in the numbers of animals such that a population cannot be maintained within the RSA or in any of the regions considered (i.e., populations will be sustainable)., Therefore, significant cumulative effects on the Furbearers VEC are not likely to occur. The planning, consultative and other effects management measures identified for this VEC will serve to avoid or reduce potential interactions and adverse effects on as a result of the Project. Avoiding or managing potential effects on Furbearers resulting from other ongoing and future projects and activities will require that appropriate resource management, planning, regulatory and enforcement measures are in place and implemented by the relevant agencies.

A description and determination of the likely cumulative environmental effects of the Project on Furbearers in each geographic region are provided in Table 12.4.9-1. For the specifics of the effects (e.g., amount of habitat altered or lost) the reader is referred to Table 12.4.7-1.

Additional mitigation is not necessary to eliminate or reduce the predicted cumulative effects on Furbearers.

Table 12.4.9-1 Cumulative Environmental Effects Summary: Furbearers

Cumulative Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Current (Baseline) VEC Condition	– Furbearer populations are stable and healthy, with limited negative effects from natural and anthropogenic influences.	– Red Fox and Beaver populations are stable and healthy, with limited negative effects from natural and anthropogenic influences. – Marten are stable within their core areas, although past logging and trapping activities have resulted in current population of approximately 600 to 800 individuals on the Island. – Porcupine do not occur in this region.	– Red Fox and Beaver populations are stable and healthy, with limited negative effects from natural and anthropogenic influences. – Marten are stable within their core areas, although past logging and trapping activities have resulted in current population of approximately 600 to 800 individuals on the Island. – Porcupine do not occur in this region.	– Red Fox and Beaver populations are stable and healthy and appear with little negative effect from natural and anthropogenic influences. – Porcupine and Marten do not occur in this region.
Likely Residual Environmental Effects of Labrador-Island Transmission Link	– Residual environmental Project effects include the loss or alteration of habitat, temporary disturbance, increased access, and changes to small mammal prey densities.	– Residual environmental Project effects include the loss or alteration of habitat, temporary disturbance, increased access, and changes to small mammal prey densities.	– Residual environmental Project effects include the loss or alteration of habitat, temporary disturbance, increased access, and changes to small mammal prey densities.	– Residual environmental Project effects include the loss or alteration of habitat, temporary disturbance, increased access, and changes to small mammal prey densities.

Table 12.4.9-1 Cumulative Environmental Effects Summary: Furbearers (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	– Future projects are likely to result in a limited increase in habitat alteration or loss and fragmentation. Access will likely increase, resulting in additional opportunities for hunting and trapping, OHV and vehicle traffic disturbance. The overlapping effects of the Project with existing and reasonably foreseeable future projects are likely to be localized (e.g., traffic along the portion of the TLH3 that is followed by the transmission line ROW; disturbance and habitat alteration or loss at the northern terminus with the Lower Churchill Falls Generation Project; habitat alteration or loss and increased access for forestry; and habitat alteration or loss and disturbance near the southern terminus near populated areas and access).	– Future projects are likely to result in a limited increase in habitat alteration or loss and fragmentation. Access will likely increase, resulting in additional opportunities for hunting and trapping, OHV and vehicle traffic disturbance. The overlapping effects of the Project with existing and reasonably foreseeable future projects are likely to be localized (e.g., traffic on the highways within the RSA; habitat alteration or loss and increased access for forestry; and habitat alteration or loss and disturbance near populated areas and access).	– Future projects are likely to result in a negligible increase in habitat alteration or loss and fragmentation. Access will likely increase, resulting in additional opportunities for hunting and trapping, OHV and vehicle traffic disturbance. The overlapping effects of the Project with existing and reasonably foreseeable future projects are likely to be localized (e.g., traffic on the highways within the RSA; habitat alteration or loss and increased access for forestry; and habitat alteration or loss and disturbance near populated areas and access).	– Future projects are likely to result in a limited increase in habitat alteration or loss and fragmentation. Access will likely increase, resulting in additional opportunities for hunting and trapping, OHV and vehicle traffic disturbance. The overlapping effects of the Project with existing and reasonably foreseeable future projects are likely to be localized (e.g., traffic on the highways within the RSA; habitat alteration or loss and increased access for forestry; and habitat alteration or loss and disturbance near populated areas and access).

Table 12.4.9-1 Cumulative Environmental Effects Summary: Furbearers (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Cumulative Environmental Effects Summary[a]	**Not Significant** – The contribution of the Project to cumulative environmental effects will primarily be limited to the LSA or potentially the RSA (relative to OHV access along the transmission ROW or access trails) and will be low in magnitude, with a far future duration. The cumulative effects are not likely to affect the KI populations on a regional basis.	**Not Significant** – The contribution of the Project to cumulative environmental effects will primarily be limited to the LSA or potentially the RSA (relative to OHV access along the transmission ROW or access trails) and will be low in magnitude, with a far future duration. The cumulative effects are not likely to affect the KI populations on a regional basis.	**Not Significant** – The contribution of the Project to cumulative environmental effects will primarily be limited to the LSA or potentially the RSA (relative to OHV access along the transmission ROW or access trails) and will be low in magnitude, with a far future duration. The cumulative effects are not likely to affect the KI populations on a regional basis.	**Not Significant** – The contribution of the Project to cumulative environmental effects will primarily be limited to the LSA or potentially the RSA (relative to OHV access along the transmission ROW or access trails) and will be low in magnitude, with a far future duration. The cumulative effects are not likely to affect the KI populations on a regional basis.

(a) Total (cumulative) change from the existing environment. The significance of cumulative effects is evaluated using the same definitions as for the Project Environmental Effects Analysis.

12.4.10 Monitoring and Follow-up

Two follow-up studies are proposed for the Furbearers VEC. The first program would investigate the effects of ROW construction and operation on marten habitat use. This program would utilize a before-after-control-impact experimental design. The study would be conducted in the Main River core area. Once a final alignment through the core area has been selected in consultation with the Canadian Forest Service and the NLDEC Wildlife Division, baseline data regarding the movement of marten through the area will be collected. Marten movement patterns will be recorded during and after construction of the ROW to determine how these activities affect marten habitat use, particularly whether or not the cleared ROW acts as a barrier to marten movement. The program will also determine the efficacy of watercourse buffer zones and brush piles and windrows as travel routes for marten. If modified vegetation management techniques are adopted to help facilitate marten movement across the ROW, the program would investigate their efficacy. Nalcor would work with the Canadian Forest Service and the NLDEC Wildlife Division to design an appropriate study which could include winter track counts.

The second study would involve assessing the degree of public access afforded by the ROW and access roads in the first winter following the completion of construction. This program would be an aerial survey conducted during the winter months to document areas of the ROW that are being used by snowmobiles. The presence and abundance of snowmobiles and snowmobile tracks would serve as an indicator of the degree of increased trapping pressure and disturbance that may be associated with increased public access. The program would also document the portions of the ROW that are accessible by snowmobiles. The advantage of conducting the program during the winter is the ability to determine where snowmobiles are accessing the ROW by following tracks. The results of the program would be used to determine: (i) how effective access control measures are; (ii) which areas of the ROW are being accessed; (iii) whether sensitive areas such as marten core areas are being accessed via the ROW; and (iv) where the access points are for snowmobiles. This information would then be used in an adaptive management framework to adjust access control measures and help minimize the potentially adverse effects of the Project on Furbearers.

12.5 Avifauna

12.5.1 Introduction

Avifauna are a valued component of ecosystems and provides a source of recreation and enjoyment for people. Birds are culturally important (e.g., raptors and certain passerines) as well as economically valuable for recreational viewing and hunting (e.g., waterfowl and upland game birds). The status of bird populations is generally indicative of the health of the ecosystem as a whole, as they feed on vegetation and lower components of the food chain, such as insects, fish, and small mammals. Avifauna are sensitive to habitat alteration or loss and a variety of other stressors, with the response varying by species.

As shown in the Avifauna Component Study (Stantec 2011f; Stantec 2010f) and as summarized in Section 10.3.7 (Existing Environment), the diversity of bird species present in the Study Area varies by region, with species composition dependent on their distribution and the availability of appropriate habitat. Chapter 10 provides an overview of the distribution of waterfowl, passerines, raptors, upland game birds, and species of special conservation status in the four regions crossed by the transmission corridor. The Strait of Belle Isle has a different variety of birds due to its marine nature and is discussed in Section 10.5.10 (Seabirds) and the effects assessment for Seabirds is discussed in Section 14.4.

Birds occupy the habitat types crossed by the Project on a seasonal (e.g., waterfowl) or year-round basis (e.g., upland game birds), depending on the species or group. Most bird species are migratory and use habitat in the Project area for breeding and rearing of young before returning to more southerly areas for overwintering.

Eight species of special conservation status, as designated by COSEWIC, *SARA* and / or the *NLESA*, were considered to breed or consistently occur within the Study Area: Harlequin Duck, Rusty Blackbird, Olive-sided

Flycatcher, Grey-cheeked Thrush, Red Crossbill, Short-eared Owl, Red Knot and Common Nighthawk. Six other species of special conservation status in Newfoundland and Labrador were evaluated, but are generally restricted to locations outside of the Study Area. These species, which include Barrow's Goldeneye, Eskimo Curlew, Piping Plover, Chimney Swift, Ivory Gull, and Peregrine Falcon, have minimal to no potential interaction with Project components and are not considered further in this assessment.

12.5.2 Environmental Assessment Study Areas

12.5.2.1 Spatial Boundaries

The LSA is the area where Project-related components and activities that may affect Avifauna will occur. The LSA therefore includes the 2 km wide transmission corridor while also considering the general nature and location of other Project activities and elements (e.g., access trails, electrode lines, camps, storage areas) (Figure 12.5.2-1).

The RSA is a broader 15 km wide study area that surrounds the LSA (Figure 12.5.2-1). This 15 km wide RSA is consistent with the area for which the ELC was prepared and habitat quality analyses were completed. The RSA was also defined with consideration of the potential spatial extent of other Project-related disturbances, such as noise and dust, which can extend up to 1 km beyond the LSA, as well as the distribution and movement of Avifauna. The RSA generally encompasses the local seasonal movements of Avifauna species during those times and life history stages during which they may interact with the Project.

12.5.2.2 Avifauna Temporal Boundaries

As described in the EA Methods section, the temporal boundaries for the effects assessment are the Construction phase (approximately 4 years) and the Operations and Maintenance phase that is assumed to occur in perpetuity.

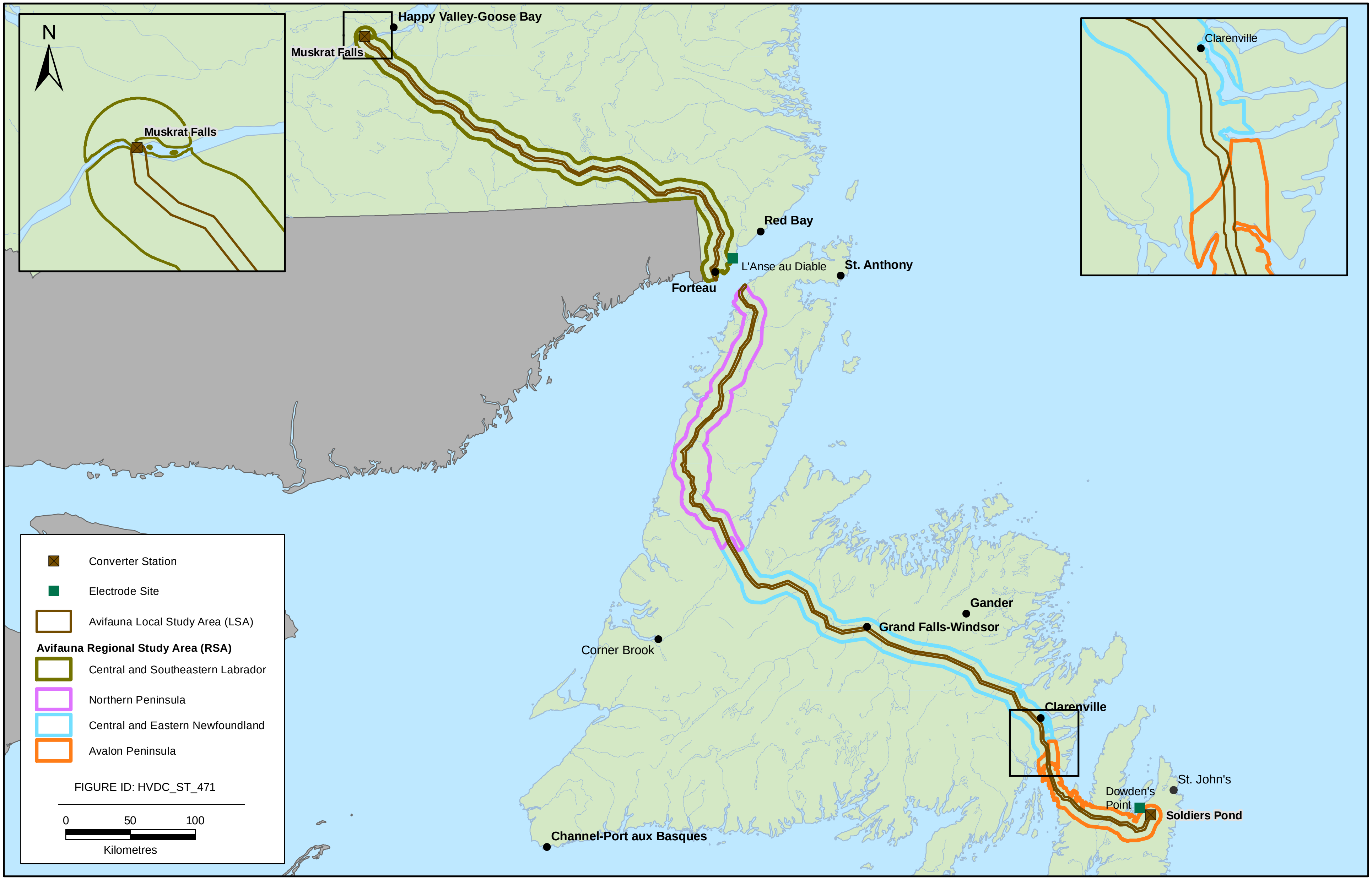
12.5.3 Potential Environmental Issues, Indicators and Interactions

12.5.3.1 Potential Environmental Issues

Potential environmental issues are those general issues associated with the Project and avifauna that have been identified in the EIS Guidelines and Scoping Document (GNL and Government of Canada 2011) through regulatory, Aboriginal and stakeholder consultation, or have been considered in previous studies on Avifauna species. While there may be some regional differences related to breeding phenology, issues related to Avifauna extend across the various regions. These issues along with rationale and any specific considerations in relation to the Project and the known sensitivities of species are summarized in Table 12.5.3-1.

12.5.3.2 Key Indicators and Measurable Parameters

To focus and frame the effects analysis, KIs for the Avifauna VEC and associated MPs were selected. Five KIs were selected: Waterfowl, Upland Game Birds, Raptors, Passerines and Species of Special Conservation Status. Note that the latter KI was chosen to address only those species of special conservation status that do not fit within the first four groups. Within each of the KIs, several species were selected for detailed consideration. Rationale for the selection of these species is provided in Table 12.5.3-2 and includes representative species, those with specialized habitat requirements, species of economic and / or cultural importance and species of special conservation status. The amount of habitat altered or lost, changes in population abundance through direct and indirect sources of mortality, numbers of nests affected, and changes in prey availability may be used as MPs for assessing Project-related effects on the selected species.



nalcor energy

FIGURE 12.5.2-1

Local and Regional Study Areas for Avifauna

Table 12.5.3-1 Identified Issues and Questions: Avifauna

Issue / Question	Nature and Rationale	Specific Considerations
Habitat alteration or loss as a result of vegetation removal during site preparation and vegetation management	– Some species have specific habitat requirements for feeding (Ruffed Grouse) or breeding (Harlequin Duck) – Some species nest in trees and low vegetation provides cover for ground nesters	– Effects on known breeding sites for Harlequin Duck on the Northern Peninsula (i.e., Torrent River, Brian's Pond River, Castor River and Inner Pond Brook); and south-eastern Newfoundland on the Bay du Nord River (IBA 2012) – Most sensitive periods are during breeding, nesting and rearing – Compliance with the *Migratory Birds Convention Act* and issues such as incidental take – Possibility of creating additional roost or nest sites for osprey along tower infrastructure – Potential alteration or loss of habitat that supports species of special conservation status
Change in prey availability for raptors as a result of clearing and vegetation management	– Prey species may avoid cleared areas or populations may increase due to edge effects, thereby altering foraging opportunities	– Predator / prey dynamics could be altered – Herbicide (i.e., Tordon) has low toxicity to Avifauna and limited effects on individual prey species
Disturbance to Avifauna species as a result of Construction, Operations and Maintenance	– Clearing and equipment operation may result in the direct disturbance of habitat / nests – Sensory disturbance could result in indirect disturbance due to the alteration of nesting habitat	– Species are most sensitive to disturbance during breeding, nesting and rearing
Direct and indirect mortality as a result of the Project	– Vehicle collisions and exposure to chemicals from small petroleum spills or herbicide spraying could result in mortalities – Increased access for hunters could result in increased mortality – Birds colliding with transmission lines could result in injury or mortality – Birds perching on the towers, lines or converter station equipment could be electrocuted	– Indirect effects due to increased access may result in increased harvesting (i.e., grouse) – Species of conservation status are of particular concern – Birds strikes or electrocution is of greatest concern in areas of high bird density and /or during migration

Table 12.5.3-2 Key Indicators and Associated Measurable Parameters: Avifauna

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Waterfowl	– Waterfowl in Newfoundland and Labrador are of ecological, cultural, and economic importance such as Canada Goose which are a common, early-breeding species found throughout the province – Many species of waterfowl are a direct indicator of aquatic ecosystem health and are widely hunted – Some species are listed such as Harlequin Duck (Vulnerable under *NLESA* and Special Concern under *SARA)* or are of international concern such as Surf Scoter (as it is exhibiting a general population decline)	– Amount of primary habitat altered relative to its availability within the RSA	– Waterfowl habitat such as fens / bogs, lakes, rivers are crossed by, or in close proximity to the Project – Canada Geese are loosely associated with specific wetland types (ribbed fens and fen-marsh complexes) – Surf Scoter are associated with willow and rocky lakes – Harlequin Duck have specific requirements for rocky, rapid-flowing rivers during nesting period – Reducing, altering or fragmenting primary habitat could affect populations
		– Change in abundance through direct and indirect mortality	– Disruption to birds due to noise and dust during Construction – Potential for nest disruption during Construction – Harlequin Duck exhibit high fidelity to breeding sites – Potential for collisions with Project infrastructure – towers and lines – Potential for collisions with Project vehicles and equipment – Potential for increased loss through hunting of Canada Goose and Surf Scoter as a result of new access – Potential for increased predation

Table 12.5.3-2 Key Indicators and Associated Measurable Parameters: Avifauna (continued)

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Passerines	– Passerines occupy a wide range of terrestrial habitats from riparian areas to burns to mature forest and most are associated with the *Migratory Birds Convention Act* – Several species have special conservation status such as Rusty Blackbird (Vulnerable by the *NLESA* and of Special Concern by *SARA*); Red Crossbill (Endangered by both *NLESA* and *SARA* as the percna subspecies is found only in Newfoundland); Grey-cheeked Thrush (Vulnerable by the *NLESA*); and Olive-sided Flycatcher (Threatened by *SARA* and the *NLESA)*	– Amount of primary habitat altered relative to its availability within the RSA	– Primary habitat may be affected by Project activities – Rusty Blackbird are associated with wetlands and surrounding forests – Red Crossbill are largely restricted to mature forests – Gray-cheeked Thrush are associated with thickets and low spruce forests with dense undergrowth – Olive-sided Flycatcher is primarily associated with specific and localized riparian and edge habitats – Blackpoll Warbler are representative of species favouring coniferous habitat – Wetland sparrows (i.e., Song Sparrow, Lincoln's Sparrow, Swamp Sparrow, and Savannah Sparrow) largely favour relatively productive and provincially uncommon riparian marshes that are relatively scarce in the province – Reducing, altering or fragmenting primary habitat could affect the population
		– Change in abundance through direct and indirect mortality	– Disruption to birds due to noise and dust during construction – Potential for disturbance / loss of nests during Construction (e.g., clearing trees with nests) and Operations and Maintenance – Potential for collisions with Project infrastructure such as towers and lines – Potential for collisions with Project vehicles and equipment – Roads and linear facilities provide increased access for predators

Table 12.5.3-2 Key Indicators and Associated Measurable Parameters: Avifauna (continued)

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Raptors	– Raptors are at the top of the food chain and are therefore indicators of ecosystem health – Osprey are indicative of the status of lower trophic levels, especially in the aquatic food web, often associated with transmission line structures – Bald Eagle are indicative of the status of lower trophic levels, especially in the aquatic food web, and may be associated with transmission line structures – Short-eared Owl are listed as Vulnerable under *NLESA* and of Special Concern under *SARA*, and are indicative of the status of lower trophic levels in the terrestrial food web	– Amount of primary habitat altered relative to its availability within the RSA – Number of nests that may be created or affected by alteration or loss of habitat	– Nesting sites are specific and breeding pairs exhibit high fidelity – Reducing, altering or fragmenting primary habitat could affect the population
		– Change in prey availability	– Snowshoe hare, meadow vole, red-backed vole are all potentially affected by Project activities – Prey numbers may increase or decrease due to edge effects and availability of foraging opportunities
		– Change in abundance through direct and indirect mortality	– Disruption to birds due to noise and dust during Construction – Potential for nest disruption during Construction – Potential for collisions with Project infrastructure such as towers and lines – Potential for collisions with Project vehicles and equipment – Potential for electrocution from lines – Potential for increased predation

Table 12.5.3-2 Key Indicators and Associated Measurable Parameters: Avifauna (continued)

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Upland Game Birds	– Upland Game Birds are species hunted for recreation and subsistence – Ruffed Grouse were selected because they are more limited in distribution than other game species due to close association with relatively uncommon deciduous forest cover, particularly aspen-dominated habitats – Willow Ptarmigan were selected to fulfill requirements of the Guidelines issued by the GNL and the Government of Canada (2011)	– Amount of primary habitat altered relative to its availability within the RSA	– Specific food and cover requirements – Reducing, altering or fragmenting primary habitat could affect the population
		– Change in abundance through direct, indirect and induced mortality	– Disruption to birds due to noise and dust during construction – Potential for nest disruption during construction – Potential for collisions with Project infrastructure – towers and lines – Potential for collisions with Project vehicles and equipment – Potential for increased loss through hunting as a result of new access – Potential for increased predation
Other Species of Special Conservation Status	– Common Nighthawk are listed as Threatened under both *SARA* and the *NLESA,* and is known to utilize a diversity of open habitats – Common Nighthawk is known to breed in Labrador but is uncommon on the Island of Newfoundland – Red Knot is designated as Endangered under the *NLESA* and by COSEWIC – Red Knot is not known to breed in the province, but do stop over during their southward migration in the fall and are known to consistently use certain coastal areas towards the western end of the Avalon Peninsula	– Amount of primary habitat altered relative to its availability within the RSA	– Primary habitat may be affected by Project activities – Reducing, altering or fragmenting the primary habitat areas could affect the population
		– Disturbance to coastal migratory stopover habitat	– Stopover habitats are essential to successful bird migrations – Reducing, altering or fragmenting key migratory stopover habitat could affect the population
		– Change in abundance through direct and indirect mortality	– Disruption to birds due to noise and dust during construction – Potential for collisions with Project infrastructure such as towers and lines – Potential for collisions with Project vehicles and equipment – Potential for disruption of nests during construction (e.g., clearing trees with nests) and Operations and Maintenance – Roads and linear facilities provide increased access for predators

12.5.3.3 Potential Project-Avifauna Interactions

A number of Project activities can potentially affect Avifauna, including habitat alteration or loss, sensory disturbance, interactions with Project infrastructure, and other forms of indirect and direct mortality. These effects would be noted for all the Project components, including the access, ROW, temporary camps, marshalling yards, electrode sites and electrode lines.

The Project will result in the clearing and disturbance of vegetation and this has potential to influence a variety of Avifauna species through the direct alteration of their habitats. Habitats that may be affected include those associated with upland, wetland, and riparian ecosystems. Habitat alteration may affect birds in a variety of ways, including the loss of nesting sites and changes to feeding opportunities.

Construction will proceed from multiple points along the 60 m wide ROW. The presence of humans, construction noise and dust could result in sensory disturbance and temporary avoidance of an area by some species. Additionally, there is the potential for other interactions between avifauna and Project equipment and activities during the Construction phase, including collisions with vehicles or disturbance to nests, as well as spills, malfunctions and other accidents that could affect habitats by altering soil and water quality.

The construction of access roads and the ROW could also result in increased public access and use of the area by Off Highway Vehicles (OHVs). Increased human access has the potential to influence avian communities by initiating changes in hunting patterns that could continue for the life of the Project.

A variety of human activities will be associated with the Project during the Operations and Maintenance phase, including routine line inspections, repairs as required, and vegetation management along the ROW. Alteration of the regenerated habitat will result from the mechanical and chemical vegetation management activities. Vegetation management will likely commence in year eight of operations, and occur every seven years thereafter, or as required for safety. During maintenance and inspection activities, sensory disturbance may result in temporary avoidance of the area by Avifauna and / or disturbance of nesting activities. Injury or mortality of avifauna may also occur from individuals flying into lines, towers, and vehicles.

Interactions of Project activities and physical works with selected KIs determined the scope of the assessment. The specific number, location and characteristics of all construction activities will be determined as part of ongoing Project engineering and design. Table 12.5.3-3 identifies the Project components and activities and how they could interact with the KIs for the Avifauna VEC.

Table 12.5.3-3 Potential Project Interactions: Avifauna

Project	**Key Indicator**				
Phase / Activity	**Waterfowl**	**Passerines**	**Raptors**	**Upland Game Birds**	**Other Species of Special Conservation Status**
Construction					
Construction of access trails and roads	– Habitat alteration or loss – Sensory disturbance[(a)] – Changes in hunting patterns due to increased access – Collisions and incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Increased prey availability – Changes in hunting patterns due to increased access – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Loss of vegetation for feeding – Changes in hunting patterns due to increased access – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Loss of vegetation for feeding – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat

Table 12.5.3-3 Potential Project Interactions: Avifauna (continued)

Project	Key Indicator				
Phase / Activity	**Waterfowl**	**Passerines**	**Raptors**	**Upland Game Birds**	**Other Species of Special Conservation Status**
Movement and presence of personnel, equipment and materials	– Sensory disturbance – Collisions and incidental take through interactions with equipment – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Sensory disturbance – Avoidance of the area – Collisions and incidental take through interactions with equipment – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Sensory disturbance – Avoidance of the area – Collisions and incidental take through interactions with equipment – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Sensory disturbance – Avoidance of the area – Collisions and incidental take through interactions with equipment – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Sensory disturbance – Avoidance of the area – Collisions and incidental take through interactions with equipment – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat
Construction camps	– Sensory disturbance	– Sensory disturbance	– Sensory disturbance	– Sensory disturbance	– Sensory disturbance
Marshalling yards and staging areas	– Sensory disturbance – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Increased prey availability – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Loss of vegetation for feeding – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Collisions and incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat

Table 12.5.3-3 Potential Project Interactions: Avifauna (continued)

Project	Key Indicator				
Phase / Activity	**Waterfowl**	**Passerines**	**Raptors**	**Upland Game Birds**	**Other Species of Special Conservation Status**
Right-of-way clearing and preparation	– Sensory disturbance – Incidental take due to loss of nest sites along waterways – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Increased prey availability – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Loss of vegetation for feeding – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Loss of vegetation for feeding – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat
Quarrying and borrowing	– Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Habitat alteration or loss – Incidental take due to clearing – Sensory disturbance – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat

Table 12.5.3-3 Potential Project Interactions: Avifauna (continued)

<table>
<tr><th>Project</th><th colspan="5">Key Indicator</th></tr>
<tr><th>Phase / Activity</th><th>Waterfowl</th><th>Passerines</th><th>Raptors</th><th>Upland Game Birds</th><th>Other Species of Special Conservation Status</th></tr>
<tr><td>Transmission tower assembly and installation</td><td>– Sensory disturbance
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals</td><td>– Habitat alteration or loss
– Sensory disturbance
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td><td>– Habitat alteration or loss
– Sensory disturbance
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td><td>– Habitat alteration or loss
– Sensory disturbance
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td><td>– Habitat alteration or loss
– Sensory disturbance
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td></tr>
<tr><td>Conductor installation</td><td>– Sensory disturbance
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals</td><td>– Sensory disturbance
– Avoidance of the area
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td><td>– Sensory disturbance
– Avoidance of the area
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td><td>– Sensory disturbance
– Avoidance of the area
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td><td>– Sensory disturbance
– Avoidance of the area
– Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat</td></tr>
<tr><td>Converter station site preparation and construction</td><td>– All interactions as listed for transmission tower assembly and installation</td><td rowspan="2">– All interactions as listed for transmission tower assembly and installation</td><td rowspan="2">– All interactions as listed for transmission tower assembly and installation</td><td rowspan="2">– All interactions as listed for transmission tower assembly and installation</td><td>– All interactions as listed for transmission tower assembly and installation</td></tr>
<tr><td>Preparation and construction of submarine cable landing sites (on-land works)</td><td rowspan="2">—</td><td>– Habitat alteration or loss
– Sensory disturbance</td></tr>
<tr><td>Construction and installation of submarine cables (Marine works)</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
</table>

Table 12.5.3-3 Potential Project Interactions: Avifauna (continued)

Project	Key Indicator				
Phase / Activity	**Waterfowl**	**Passerines**	**Raptors**	**Upland Game Birds**	**Other Species of Special Conservation Status**
Electrode site preparation and installation Island system upgrades	– All interactions as listed for transmission tower assembly and installation	– All interactions as listed for transmission tower assembly and installation	– All interactions as listed for transmission tower assembly and installation	– All interactions as listed for transmission tower assembly and installation	– All interactions as listed for transmission tower assembly and installation
Employment / presence of workers	– Sensory disturbance	– Sensory disturbance	– Sensory disturbance	– Sensory disturbance	– Sensory disturbance
Contracting / expenditures System commissioning	—	—	—	—	—
Operations and Maintenance					
Access trails and roads	– Sensory disturbance – Access could increase hunting pressure	– Sensory disturbance – Disruption during nesting causing mortalities	– Sensory disturbance	– Sensory disturbance – Access could increase hunting pressure – Disruption during nesting causing mortalities	– Sensory disturbance – Disruption during nesting causing mortalities
Presence and operation of the transmission system	– Sensory disturbance – Flying into lines and towers	– Sensory disturbance – Flying into lines and towers	– Sensory disturbance – Flying into lines and towers – Use of tower infrastructure as nest sites	– Sensory disturbance	– Sensory disturbance – Flying into lines and towers

Table 12.5.3-3 Potential Project Interactions: Avifauna (continued)

Project	Key Indicator				
Phase / Activity	**Waterfowl**	**Passerines**	**Raptors**	**Upland Game Birds**	**Other Species of Special Conservation Status**
Routine line inspections and repairs	– Sensory disturbance – Incidental take through interactions with vehicles – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Sensory disturbance – Incidental take through interactions with vehicles – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Sensory disturbance – Incidental take through interactions with vehicles – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Sensory disturbance – Incidental take through interactions with vehicles – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Sensory disturbance – Incidental take through interactions with vehicles – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat
Vegetation management	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take due to clearing – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat

Table 12.5.3-3 Potential Project Interactions: Avifauna (continued)

Project	Key Indicator				
Phase / Activity	**Waterfowl**	**Passerines**	**Raptors**	**Upland Game Birds**	**Other Species of Special Conservation Status**
Potential major system repairs	– Habitat alteration or loss – Sensory disturbance – Incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat or oiling of individuals	– Habitat alteration or loss – Sensory disturbance – Incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat	– Habitat alteration or loss – Sensory disturbance – Incidental take through interactions with vehicles and other machinery – Spills, malfunctions and other accidents could alter soil and water quality, and result in alteration or loss of habitat
Operation of the electrodes	– Collisions with associated power lines	– Collisions with associated power lines	– Use of associated power poles as nest sites – Electrocutions on associated power lines – Collisions with associated power lines	– Collisions with associated power lines	– Collisions with associated power lines
Employment / presence of workers	—	—	—	—	—
Contracting / expenditures					

Note: Incidental take refers to the inadvertent destruction of the nests and eggs of migratory birds during the breeding season.

— Indicates no likely or detectable interaction identified.

(a) Refers to reduced habitat availability due to disturbance from human activity, noise, and predator avoidance.

12.5.4 Approach to the Environmental Effects Analysis

12.5.4.1 Analytical Methods

Baseline conditions were characterized for Avifauna based on studies conducted over the last 20 years by various authors throughout the province, as presented in the Avifauna Component Study (Stantec 2010f) and the Avifauna Component Study Supplementary Report (Stantec 2011f). These baseline reports considered species numbers / density, current habitat associations, limiting factors, prey species, foraging opportunities, and factors potentially affecting species stability.

For construction, a key issue is the potential alteration or loss of habitat due to vegetation clearing. Where possible, an estimate of this loss has been quantified by region. This quantification is based on predicted effects to habitat that was classified as primary, secondary and tertiary for representative species within the Project ELC (Stantec 2011a; Stantec 2010b) in the Avifauna Component Study (Stantec 2010f) and the Avifauna Component Study Supplementary Report (Stantec 2011f). Primary habitat was defined as habitat that provides foraging, protection, nesting and resting habitat. Secondary habitat provides an abundance of one or more (or marginal amounts of all) of the critical elements. Tertiary habitat provides marginal foraging, protection or resting opportunities or may be used only during transit. Maps were colour-coded to reflect the amount and distribution of habitat quality on an ecoregion by ecoregion basis within each of the four geographic regions, and are included in the Avifauna Component Study (Stantec 2012b, 2010f) and the Avifauna Component Study Supplementary Report (Stantec 2011f).

The assessment includes an estimation of the quantity of primary habitat potentially altered or lost as a result of the Project. To inform this estimate, the centre line ROW is assumed to be 60 m wide centred within the 2 km wide transmission corridor. The final alignment of the ROW within the corridor will ultimately depend on a number of factors, including the avoidance of sensitive environmental features where practical. As indicated in Section 12.2.4.1, to account for anticipated alignment deviations and uncertainty in the location of other Project components (e.g., access roads) and to be conservative, Nalcor applied a 20% contingency to all estimates of habitat loss or alteration due to clearing of the ROW to account for final alignment deviations. For each KI, the amount of primary habitat was determined for the entire ROW and RSA using the ELC in a GIS. The amount of primary habitat within the representative centre line ROW was expressed as a percentage of the total primary habitat available within the RSA to estimate the scale of potential habitat alteration or loss. The habitat classification and ensuing spatial assessment of potential Project effects was completed for nine species (i.e., Canada Goose, Rusty Blackbird, Grey-cheeked Thrush, Blackpoll Warbler, Short-eared Owl, Ruffed Grouse, Common Nighthawk, American Black Duck and Ring-necked Duck) and one guild (i.e., wetland sparrows). Data from the ELC on wetland forms and riparian shoreline within the corridor and centre line ROW were used to provide additional insight into the potential effects of Project Construction on preferred Canada Goose and wetland sparrow habitat, respectively.

Note that for many of the species selected to represent KIs (i.e., Harlequin Duck, Surf Scoter, Red Crossbill, Olive-sided Flycatcher, Osprey, Bald Eagle and Red Knot) it was not possible to assign habitat quality at the mapping scale for this Project. Habitat requirements of these species are based on small-scale and localized biophysical parameters that could not be quantified and mapped based on the habitat types delineated in the ELC. For these species a more qualitative assessment was conducted based on specific known occurrences.

A qualitative approach is also used for assessing the likely effects of issues other than the alteration or loss of habitat on avifauna, such as sensory disturbance, interactions with Project infrastructure (e.g., collisions and electrocutions), and other potential forms of direct and indirect mortality. The effects of the Project in relation to these issues were assessed based on knowledge gained from other studies and information on the distribution, abundance, ecology and behaviour of these avifauna species within the Study Area.

For the purposes of this assessment, the effects analysis considers the nature and degree of Project-induced change from baseline conditions, following implementation of mitigation practices by Nalcor.

12.5.4.2 Environmental Effects Descriptors

The environmental effects of the Project on each Avifauna KI were described using five attributes: direction, magnitude, geographic extent, duration and frequency. Values assigned to the various levels of these descriptors are consistent with other EAs in the province (e.g., Nalcor 2009; Vale Inco Newfoundland and Labrador Limited 2008; Newfoundland and Labrador Refining Corporation 2007). While frequency is not defined in Table 12.5.4-1, is used to describe the likely Project effects on the Avifauna KIs.

Table 12.5.4-1 Effects Descriptors: Avifauna

Effects Descriptor	Definition
Direction[a]	
Adverse	– Decreased prey availability – Habitat alteration or loss – Direct or indirect mortality through vehicle collisions or increased hunting / trapping pressure
Neutral	– No increase or decrease in abundance, habitat, prey availability
Beneficial	– Increased foraging opportunities – Enhancement of habitat – Increased access to feeding areas / prey species – Availability of nesting sites on towers
Magnitude[b]	
No effect	– No potential effect on KI
Low	– <5% of the population or primary habitat within the RSA will be exposed to the effect – Predicted to result in no measurable change in habitat availability or population size relative to baseline conditions
Moderate	– 5% to 25% of the population or primary habitat within the RSA will be exposed to the effect – Predicted to result in a measurable change in habitat availability or population size relative to baseline conditions that does not cause management concern
High	– >25% of the population or primary habitat within the RSA will be exposed to the effect – Predicted to result in a measurable change in habitat availability or population size relative to baseline conditions that does cause management concern
Geographic Extent[c]	
Local	– Environmental effects confined to the LSA
Regional	– Environmental effects confined to the RSA
Beyond regional	– Environmental effects extend beyond the RSA
Duration	
Short-term	– Effect will be evident for less than one year
Medium-term	– Effect will be evident for between one and four years (Construction period)
Long-term	– Effect will be evident for longer than four years, but does not extend more than 30 years
Far future	– Effect will be evident throughout Project Operations and Maintenance

[a] Degree of change from baseline condition.
[b] Nalcor 2009; Vale Inco Newfoundland and Labrador Limited 2008; Newfoundland and Labrador Refining Corporation 2007.
[c] Spatial area within which an effect may occur.

12.5.5 Construction

12.5.5.1 Overview of Project Construction and Associated Effects Management

Habitat Loss

Loss or alteration of habitat is a key issue for Avifauna during Construction. In particular, clearing of the access and ROW and construction of Project infrastructure could result in the alteration or loss of potential breeding, nesting, rearing or other habitat for various species. The anticipated effects related to the alteration or loss of habitat, are therefore discussed in detail below for each of the key Avifauna species considered in this assessment. In general, alteration or loss of habitat for species that prefer wetland and riparian habitats (e.g., waterfowl, some passerines) will be limited by Nalcor's plans for following standard mitigation measures for wetlands and riparian zones, including avoidance, setbacks and buffers to the extent practical. The mitigation measures identified in Section 12.2.5 to mitigate potential effects on vegetation, such as reducing the width of disturbance, where practical, and reclaiming disturbed areas will also limit potential environmental effects on avifauna.

As a result of vegetation clearing, some Avifauna will likely be displaced from affected areas and this could result in a change in their distribution. The movement of displaced individuals into other, possibly lower quality areas, could increase crowding and subsequent inter- and intra-specific competition for food and other resources. The resulting physical stress could have implications for reproductive output and survival. Changes in distribution and abundance will be a function of the availability and productivity of alternate breeding sites within the LSA.

Sensory Disturbance

Construction activities, including quarrying and borrowing, will create disturbance (particularly noise and dust) that may negatively influence the effectiveness of habitat for avifauna. Such activities could influence the fitness levels of individuals in a variety of ways, including through displacement to less productive feeding areas or through increased stress levels. Areas which support staging, breeding, nesting, or brood rearing for waterfowl, raptors, and other species are considered especially susceptible to sensory disturbance. Disturbance due to noise or visual stimuli can also cause increased energy expenditures in birds even during non-breeding periods, with juvenile birds being particularly sensitive due to their energy requirements for growth and maintenance (Department of National Defence (DND) 1994). Dust can influence the productivity of adjacent wetlands by limiting the penetration of sunlight as it settles on water, and through clogging the pores of photosynthesizing plants. This issue will be addressed through a series of mitigation measures outlined in the EPP to control dust emissions (refer also to mitigation proposed for Air Quality in Section 11.2.5). In addition to noise, visual profile, and dust; smell may also provide important sources of sensory disturbance to wildlife.

The primary effects of noise are the masking of key auditory signals such as mating calls and prey sounds. Secondary effects are non auditory in nature, and include increased stress levels and changes in mating and feeding patterns (Manci et al. 1988). Masking becomes an issue when the noise levels are able to exceed acoustic signals on which an animal relies for survival, such as defending territory, attracting mates, or delivering distress calls (Warren et al. 2006). Field studies have revealed that birds adjust their vocalization to reduce the influence of background noise levels (Patricelli and Blickley 2006). For example, Song Sparrows have been found to shift the fundamental frequency of their songs from the lower frequency range (i.e., commonly found with urban noise), into the higher frequencies (i.e., above 4,000 Hz) in response to changes in their environment (Wood and Yezerinac 2006). It has been found that higher-pitched frequencies in bird songs may make species less susceptible to noise effects from roads (Rheindt 2003). Birds may also adapt to noisy environments by increasing the amplitude (Brumm 2004), increasing the duration and altering the timing of songs (Patricelli and Blickley 2006). Although difficult to quantify, the breeding behaviour and success of some species of birds whose mating system is driven by auditory cues may be affected by noise levels adjacent to construction activities and operational units. However, the human presence and industrial environment is expected to deter wildlife from interacting within close proximity of areas where high sound levels may create masking effects of concern for some species.

Noise levels that have an effect on wildlife vary with the species, the time of day, habitat, season and other potentially masking sounds in the area. For waterfowl, noise thresholds of 80 to 85 dBA are known to initiate behavioural responses (Goudie and Jones 2004; Bowles et al. 1991). In general, a noise level that exceeds another by about 20 dBA may hamper the natural communication mechanisms of wildlife and may represent an adverse effect. With the exception of areas in close proximity to rapids or roads in the existing environment, sustained noise levels of 55 dBA at night or 65 dBA during the day would represent a zone of influence in the LSA. Most noise emissions from Project Construction will not be detected above ambient noise levels beyond 1 km for a drill rig, or at much less distance for most other activities (Table 11.2.5-10). Access roads will be developed from existing roads to select points on the transmission line, and a construction access trail is will be required along the length of the corridor. Conventional construction techniques will be used, resulting in localized noise for finite time periods. Clearing and preparation of the ROW or installation of the electrode lines will be accomplished primarily by diesel powered vehicles (including mechanical harvesters), and will also include workers with chainsaws in accordance with standard utility practices and procedures. These activities will generate essentially the same level of noise as timber harvesting and clearing for public roads. The activities and associated noise levels are understood and localized in both space and time within the LSA. An increase in noise levels in a given location is likely to be perceptible (more than 3 dBA increase) for a period of three to four days.

The movement of materials will be accomplished by tracked vehicle (e.g., nodwell or small tractors). At any one location where noise may be detected, these activities will be infrequent and of short duration. The associated sound emissions released from the operation of this equipment will be minimal and will move as the construction locus moves along the ROW. Temporary construction camps will be managed to ensure that workers are rested and healthy. Sound pressure levels within the camps will be governed accordingly, although limited sounds will escape the camp boundaries. The environmental effects of moving materials from marshalling yards and staging areas using trucks and cranes will be consistent with those of other construction equipment (Table 11.2.5-8). Blasting may be required during the construction of the converter station or during the assembly and installation of the towers. However, the sound emissions will be localized, short in duration (i.e., <4 days per tower) and will be limited by the application of standard mitigation (e.g., use of blasting mats in environmentally sensitive areas, maintaining equipment in good running order).

Noise emissions during Construction could cause some alteration in the distribution of Avifauna adjacent to areas of elevated noise. Construction noise is estimated to be at ambient levels at a maximum distance of 1 km from the source, and will be temporary as Construction activities move along the ROW.

Aircraft overflights have the potential to disturb a larger proportion of a population when birds are concentrated, such as during staging or during nesting if the species is a colonial breeder. Reactions to overflights vary by species, season, breeding condition, flock size, and other parameters such as aircraft type, height, and altitude (Ward et al. 1986; Gollop et al. 1974). Helicopters may be used to move equipment or materials, depending on the terrain and site-specific conditions.

Direct and Indirect Mortality

The potential for mortality due to vehicle collisions will be present during Construction when vehicle traffic associated with the Project will be at its highest. Although this is a potential issue for all KIs, it is of particular relevance for passerines because they are low-flying birds and are known to be susceptible to vehicle collisions (Erickson et al. 2005). Upland Game Bird species are also low-flying and at risk of collisions with Project vehicles or other equipment, particularly during fall when juveniles are dispersing. In comparison to these relatively susceptible groups, the number of waterfowl and raptor fatalities due to vehicle interactions are generally much less (Erickson et. al. 2005). Vehicle collisions with other Species of Special Conservation Status might also be an issue. For example, in addition to a number of other factors (e.g., decreases in prey base, nest predation), declines in the abundance of the Common Nighthawk have been partly attributed to vehicle collisions (Iron and Pittaway 2000).

Spills of fuels and other hazardous or controlled products during construction could also lead to the direct or
Spills of fuels and other hazardous or controlled products during construction could also lead to the direct or
indirect mortality of Avifauna, such as through contamination of habitat and food sources. Birds that spend large periods of time on the water, are weak fliers that dive often, have flightless feather-moulting stages, dive to feed, and roost at night on water are particularly susceptible to oiling (Lock et al. 1994; Piatt et al. 1985). As such, Waterfowl are typically sensitive to such pollution and areas where they congregate for staging, feeding, and / or breeding purposes are especially sensitive (Baker et al. 1991). Birds coated with oil may be physically impaired to the extent that they are unable to fly or forage (Lock et al. 1994; Koeth and Vauk-Hentzelt 1988). Oil clogs the fine structure of feathers, leading to loss of body heat and buoyancy, and may result in drowning. Physiological stress due to oiling increases when the metabolic rate of oiled birds rises to maintain body temperature. The likelihood and environmental effects of spills will be minimized by following standard mitigation practices for the storage and handling of fuels and other hazardous or controlled products.

Mitigation

Mitigation designed to limit the loss or alteration of vegetation are discussed for the Vegetation VEC (including wetlands and riparian habitat) in Section 12.2.5 and are also effective for limiting potential effects on Avifauna habitat. Nalcor will also have in place a number of mitigation measures designed specifically to reduce potential environmental effects on Avifauna. Relevant mitigation measures for vegetation and those specific to Avifauna include:

- An avifauna management plan will be finalized and implemented (Environment Canada 2007a) to address all vegetation clearing and reduce the possibility of inadvertent destruction of the nests and eggs of migratory birds, and included in the EPP.
- Final ROW alignment and access routing will consider the location of known high concentrations of waterfowl to the extent possible.
- The final ROW alignment will avoid known breeding sites where feasible.
- Existing trails, roads or cut-lines will be used and development of new access will be minimized, to the extent practical, to avoid disturbance to riparian vegetation and, where practical, access roads and trails will be located to avoid riparian shoreline.
- A pre-Construction survey will be conducted to identify the location of Bald Eagle and Osprey (or other raptor species if detected) nests.
- Nest searches will be conducted prior to clearing if clearing activities are conducted during the breeding season of other (non-raptor) migratory birds, and a 30 m buffer around active nests will be maintained during construction activities to demonstrate due diligence in terms of the *Migratory Birds Convention Act.*
- Clearing activities will only occur within the ROW and other site specific areas (i.e., converter station, marshalling yards, camps).
- Clearing will not be conducted within 800 m of an active raptor nest during the nesting period (May 15 to July 31) unless clearing is delayed until the nest is no longer occupied; and, clearing will not be conducted within 200 m of an active raptor nest during the non-nesting season.
- Where nests must be cleared, mitigation involving placement of artificial nests will be implemented, if appropriate, in consultation with the NLDEC Wildlife Division.
- At watercourse crossings, the width of the cleared ROW will be reduced to 3 m for a minimum 15 m distance away from the shoreline. Where practical, the reduced ROW width will apply for the entire buffer zone if greater than 15 m. Selective cutting may occur in these areas.
- A vegetated buffer extending 30 m from the water's edge will be maintained for the transmission line ROW to protect known waterfowl staging areas.

- Buffer zones (non-disturbance areas) of various widths around watercourses and waterbodies will be implemented as follows:
  - Approval will be obtained from the Government of Newfoundland and Labrador for development activities to take place within riparian areas in a designated PPWSA (Section 48 *Water Resources Act* 2002 (GNL 2002, internet site)); activities that could aggravate flooding or result in unmitigated adverse water quality effects will not be permitted. Development and approval will be obtained for activities to take place within a prescribed distance from the edge of a watercourse or waterbody, as follows:

Waterbody	Minimum Buffer Width
Intake lake or pond	150 m
River intake	150 m (applied 1 km upstream and 100 m downstream)
Major river channel	75 m
Major tributaries, lakes or ponds	50 m
Other waterbodies	30 m

  - In non-PPWSA, the minimum buffer zone width will be determined using the formula: 12 m + 1.5 m x slope of the land (percent) or 20 m, whichever is larger.
  - To protect scheduled salmon rivers, a minimum 30 m buffer will remain from the high water mark (DFO 2009, internet site).
- Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures:
  - all vegetation shall be cut within 150 mm of the surface of the ground;
  - all vegetation that exceeds 2 m height at maturity will be cut;
  - trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed; and
  - merchantable timber will be cleared through various means (e.g., feller-buncher (mechanical), hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m.
- Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats.
- A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage.
- Stockpiled salvaged timber, slash, brush and debris will be removed within 6 m of each side of the ROW centre line.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.
- Refuelling and maintaining of equipment and machinery will not be permitted within 50 m of a waterbody, wetland or flood-prone area.
- Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act*.
- Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, Construction Supervisor, or designated Project personnel.

- Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response.
- Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic.
- Well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed.
- During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.
- Haul distances for construction material will be limited to the extent practical.
- Construction activities will be conducted in accordance with municipal by-laws regarding noise.
- High noise-producing construction equipment will be strategically placed as far away as practical from receptors.
- Blasting activities will be designed and undertaken in compliance with provincial and federal regulations.
- Blasting mats will be used in environmentally sensitive areas as defined in the EPP.
- The size of explosive charges will be limited during blasting activities.
- Construction staging areas will be located and operated in a manner that limits disturbance to native vegetation to the extent practical.
- Unless otherwise agreed upon with the NLDEC, all construction materials and debris will be removed from marshalling yards and construction staging areas when Construction is complete, and the areas returned to original land use capability, regraded and allowed to revegetate naturally.
- Permanent or temporary camps will not be established within 800 m of an active raptor nest.
- No work will be conducted within 200 m of an active raptor nest unless in consultation with the NLDEC Wildlife Division.
- Construction activities will not take place from May 1 to July 31 within the immediate vicinity of locations where breeding pairs of Harlequin Ducks have been recorded to minimize the potential for sensory disturbance.
- Work activities will be conducted in a manner that does not deliberately harass wildlife, including avifauna.
- Only essential vehicular activity, including helicopter flights, will be permitted along the transmission line route to minimize disturbance to wildlife, including avifauna.
- Project personnel will not be permitted to possess firearms or have pets on-site and Nalcor will enforce a ‘no-harvesting’ policy during working hours. The exception to firearm possession will be bear monitors as described in the EPP.

12.5.5.2 Existing Knowledge

Table 12.5.5-1 presents summaries of some of the literature available regarding the potential effects of the Project on Avifauna. As identified previously, two of the key issues associated with Construction include alteration or loss of habitat due to clearing and sensory disturbance from Construction activities. References related to clear-cutting are provided for background information. However, the cleared 60 m wide ROW is comparable more to issues of access and other linear developments than forestry cutblocks, which tend to be much larger.

Table 12.5.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Avifauna

Reference	Study / Project Context	Summary of Findings
Mitchell et al. (2009, internet site)	Movement of juvenile songbirds in harvested boreal forest: assessing residency time and landscape connectivity	– Tested the hypothesis that regenerating clear-cut land cover would affect the movement of juvenile warblers differently than forested land cover – Found that residency time decreased in clear-cut neighbourhoods and landscape connectivity was impeded by clear-cut land cover – Results suggest that clear-cut land cover may represent low-quality habitat for species during the post-fledging period
Whitaker et al. (2008)	Survival of adult songbirds in boreal forest landscapes fragmented by clearcuts and natural openings	– Boreal songbird populations maintain resilience to naturally occurring landscape change through adaptable movement behaviours – Boreal birds and other animals alter movement behaviour in response to moderate changes in landscape structure such as forest harvesting – Some species likely experience reduced local survival from clear-cutting – There may be thresholds of both forest fragmentation and loss of habitat, beyond which adverse demographic effects may occur
COSEWIC (2007a, internet site)	COSEWIC assessment and status report on the Olive-sided Flycatcher *Contopus cooperi* in Canada	– Breeding success of birds nesting in harvested habitats may be lower than the breeding success of birds nesting in natural (e.g., burned) openings
Robertson and Hutto (2007)	Is selectively harvested forest an ecological trap for Olive-sided Flycatchers?	– Studied nest success of Olive-sided Flycatchers in a naturally occurring burned forest and a harvested forest – Population density and nestling provisioning rates were greater in harvested landscapes, but nest success was roughly half that found in naturally burned forest – Reduced nest success was likely attributable to a relatively high abundance of nest predators – Concluded that selectively harvested forest can act as an ''ecological trap'' by attracting Olive-sided Flycatchers to a relatively poor-quality habitat type
Hirvonen (2001)	Impacts of highway construction and traffic on a wetland bird community	– Investigated the effects of construction of a two-lane highway in Finland through wetland area characterized by shore meadows and reed swamps – Once opened to traffic, mean conservation value of the wetland bird community decreased by 25% as compared to control area, likely due to the loss of several habitat specialist species – The abundance of breeding wader birds declined in areas where traffic noise level exceeded 56 dB, while the abundance of passerine birds showed no response to disturbance by the highway, regardless of noise level

Table 12.5.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Avifauna (continued)

Reference	Study / Project Context	Summary of Findings
Thompson et al. (1999)	Avian communities in forests of Newfoundland, Canada	– Different avian communities occur in response to changes in vegetation structure and species composition following logging – 42 species of birds were recorded in Newfoundland forests, of which less than half were abundant – Bird species richness was greater in 40 year old forests – Grey-cheeked Thrush was most abundant in old growth forest
Whitaker and Montevecchi (1999)	Breeding bird assemblages inhabiting riparian buffer strips in Newfoundland, Canada	– Avian abundance is usually higher along buffer strips than prior to harvesting due to the attraction of ubiquitous species and species attracted to clear-cut edge habitats – varying size buffers tends to attract different guilds of avifauna
Bramble et al. (1994)	Nesting of breeding birds on a utility line right-of-way (ROW) in Pennsylvania, United States	– Active nests of 13 species in a ROW occurred in both hand-cut and herbicide treated segments – For the five most common species, nesting success ranged from 67-100% in three maintenance methods that resulted in shrubs, or grass and forb cover remaining at the site – This nesting success was comparable or higher relative to stands elsewhere

12.5.5.3 Construction Effects: Waterfowl

The following sections describe the predicted Project Construction effects on the known population and habitat of the identified key Waterfowl species, namely Harlequin Duck, Canada Goose and Surf Scoter. A full description of these species can be found in the Avifauna Component Study (Stantec 2012b, 2010f) and the Avifauna Component Study Supplementary Report (Stantec 2011f), including mapping of identified habitat where applicable.

Habitat Alteration or Loss

Harlequin Duck

Since habitat requirements for Harlequin Duck are based on small-scale and localized biophysical parameters (Goudie and Gilliland 2008; Environment Canada 2007b; Rodway et al. 1998), it was not possible to assign habitat quality ratings at the mapping scale conducted for this Project. However, because Harlequin Ducks have a strong affinity for specific breeding sites (Robertson and Goudie 1999), it is possible to discuss known observations of this species and breeding sites along watercourses (Stassinu Stantec Limited Partnership 2010; ACCDC 2010, internet site; ACCDC 2008, internet site; AGRA Earth and Environmental Ltd. and Harlequin Enterprises 1999) in relation to the centre line ROW and LSA:

- Traverspine River (Central and Southeastern Labrador): the centre line ROW crosses tributaries of this river approximately 18 km south-west of where a pair of Harlequin Duck were recorded in 2010;
- St. Paul River (Central and Southeastern Labrador): the centre line ROW intersects this river approximately 1 km from the location where a pair was recorded during 1998 surveys (i.e., record is on the edge of the LSA);

- Torrent River (Northern Peninsula): the centre line ROW is located approximately 5 km downstream of the main breeding area for Harlequin Ducks on this river (which is the most important breeding site on the Northern Peninsula) and no recorded observations of this species along the Torrent are known within the LSA;
- Brian's Pond River (Northern Peninsula): although the centre line ROW crosses this river downstream of the known breeding area for Harlequin Ducks, observations of this species have been recorded within the LSA;
- Castor River West (Northern Peninsula): the centre line ROW crosses this river approximately 2 km downstream of where Harlequin Duck have been observed; and
- Inner Pond Brook (Northern Peninsula): The centre line ROW crosses this brook approximately 4 km upstream of where Harlequin Duck have been recorded.

Although the LSA is located outside of the main breeding areas for most rivers, including the Torrent River, there is some concern during the early spring and summer that pairs may move through the LSA and upstream to breeding sites. Areas that support known Harlequin Duck nesting that overlap the LSA include Castor River and Brian's Pond River. An estimated 128+45 Harlequin Duck (indicated pairs) breed along the rivers of western and northern Newfoundland (Goudie and Gilliland 2008). Densities of 0.042 to 0.187 birds/km were estimated breeding on the Northern Peninsula (Gilliland et al. 2008a). These numbers may represent 20% of wintering Harlequin Ducks in Eastern North America.

Breeding pairs such as those found in these locations are particularly sensitive to disturbance as they already have low success rates. As such, construction activities in these areas will take place in the fall or winter when individuals have migrated back to coastal areas. Mitigation measures in place for riparian zones, as described in Section 12.2.5 (Vegetation) are likely to limit effects on nesting sites for Harlequin Duck. Additionally, the final ROW alignment within the transmission corridor will be sited to avoid known breeding sites and limit vegetation clearing at the edge of rivers, to the extent practical.

Canada Goose

Canada Geese breed throughout Labrador and the Island of Newfoundland. They are attracted to deltas with shallow water for foraging, and rely upon open, fast-flowing water when they arrive in early spring. For nesting, this species prefers peatlands and fluvial sites in boreal regions (Mowbray et al. 2002). In Labrador, nesting Canada Geese show a particular association with ribbed fens and fen-marsh complexes (Minaskuat Limited Partnership 2005a; Goudie and Whitman 1987). Nests are typically located on small islands within the wetland complex (Minaskuat Limited Partnership 2007, 2005a, 2004). During the avifauna surveys in support of the Project in 2008, geese were noted in wetland and scrub / heathland / wetland habitats in the Study Area (Stantec 2010f). Concentrations of moulting Canada Geese have been observed on the Eagle River (CWS unpublished data).

Table 12.5.5-2 provides the amount of primary habitat (i.e., wetland) potentially affected by Project Construction by region, as indicated by the centre line ROW (including a 20% contingency). In total for all regions, approximately 9 km^2 of primary habitat may be affected. By region, Project Construction is not expected to affect more than 4% of primary or secondary habitat available with the LSA, except for within the region of the Avalon Peninsula where disturbance to approximately 6% of primary habitat may occur. The actual amount of primary habitat affected is likely lower, as Table 12.5.5-2 represents the wetland habitat present within the centre line ROW, and does not consider Nalcor's commitment to avoid wetlands where feasible, and Canada Goose's preference for specific wetland types such as string bogs and ribbed fens that provide island nesting sites for breeding (Minaskuat Limited Partnership 2005a; Goudie and Whitman 1987).

Table 12.5.5-2 Primary Habitat for Canada Goose Potentially Affected by Construction (By Region)

Region	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	145	19	1,198	21	4	3	<1
Northern Peninsula	40	8	256	5	1	4	<1
Central and Eastern Newfoundland	83	13	716	15	3	3	<1
Avalon Peninsula	7	3	63	4	<1	6	1

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.

More detailed data on the distribution and abundance of wetland habitats within the LSA and centre line ROW, as provided in Section 12.2.5 (Vegetation), provides additional insight into the likely effects of Project Construction on Canada Goose Habitat. In particular, effects to specific wetland habitats within the LSA are less than 5%, with the exception of slope bog / ribbed fen complexes (10%) in the Central and Southeastern Labrador Region, and ribbed fen / slope fen complexes (8%) and slope fens (6%) on the Northern Peninsula. The amount of primary habitat affected by construction activities represents 1% or less of that present within the RSA for any of the four regions. As such, the predicted loss of primary habitat due to Construction activities will have a small measurable effect on habitat availability at the local scale and little if any effect at the regional scale.

Surf Scoter

Surf Scoter breed throughout the Central and Southeastern Labrador region. The species does not breed in Newfoundland, although they are present during staging and moulting (Warkentin and Newton 2009). Primary, secondary and tertiary habitats associated with Surf Scoter are not easy to discern due to the highly specific and localized nature of preferred habitat features (i.e., shallow, rocky lakes at higher elevations) (Warkentin and Newton 2009; Savard et al. 1998; Savard and Lamothe 1991; Goudie and Whitman 1987). Alteration or loss of habitat for Surf Scoter will occur primarily through clearing of the ROW where it crosses or closely approaches shallow and rocky ponds or lakes. Mitigation in place for riparian zones, as described in Section 12.2.5 (Vegetation), and avoidance of lakes and large wetlands to the extent practical are likely to limit effects on Surf Scoter.

Habitat Alteration due to Sensory Disturbance to Diving Ducks

Areas which support staging, breeding, nesting, or brood rearing Waterfowl are considered especially susceptible to sensory disturbance. For example, although Harlequin Ducks are somewhat tolerant of moderate levels of disturbance within other parts of their range (Brodeur et al. 2008; Clarkson 1994; Savard 1988), they are known to abandon sites when disturbance levels become chronic (Hunt 1998; Clarkson 1994; Cassirer and Groves 1991). They have been shown to avoid areas of human activity during early brood-rearing (Kuchel 1977) and exhibit reduced reproductive success near human activity (Cassirer and Groves 1991; Bengston 1972), particularly during nesting, incubation, and brood rearing (mid-June to mid-August in Labrador) (Bighorn Environmental Design Ltd. 1996). Disturbance due to noise or visual stimuli can cause increased energy expenditure in birds even during non-breeding periods, with juvenile birds being particularly sensitive due to their energy requirements for growth and maintenance (DND 1994). If disturbed, Waterfowl may expend energy to escape or at least spend less time feeding, both of which affect fat reserves critical for migration.

Estimated noise levels for the Project indicate that Construction noise along access roads and in construction areas would create noise levels of 90 dBA at a distance of 23 m from the source (i.e., blasting) , but that this would vary depending on variables such as snow cover, tree cover and wind speed. Considering that these levels exceed the 80 to 85 dBA thresholds known to initiate behavioural responses in Waterfowl (Goudie and Jones 2004; Bowles et al. 1991), sensory disturbance may initiate behavioural responses within a similar distance. Noise levels in the vicinity of the horizontal direction drill sites will be 70 dBA at 50 m. However, because construction noise is estimated to be at ambient levels within 1 km (depending on-site conditions), there is some potential for Waterfowl throughout the LSA to be exposed to temporarily elevated noise levels as construction activities move along the ROW. To reduce sensory disturbance that could lead to indirect habitat loss, construction activities in the immediate vicinity of known sensitive sites (i.e., breeding locations) for Harlequin Duck will not take place during the breeding period from May 1 to July 31.

Direct and Indirect Mortality

Potential sources of direct and indirect Waterfowl mortality include pollution from fuels and other hazardous or controlled products and vehicle collisions. Due to their ecology and behaviour, Waterfowl are sensitive to spills of fuels and other hazardous or controlled products, particularly in areas where they congregate for staging, feeding, and / or breeding purposes (Baker et al. 1991). However, as previously discussed, the likelihood and environmental effects of spills will be minimized by following standard mitigation practices for the storage and handling of fuels and other hazardous or controlled products. Although they are not generally as susceptible to vehicle collisions as some other bird groups, there will be ongoing potential for interactions between Waterfowl and Project machinery during the Construction phase. Waterfowl collisions along roadways have been reported to be common in some areas, but do not necessarily account for sources of population mortality. For example, a survey of duck collisions along roadways in the prairies found fatalities to represent less than 0.2% of the breeding population in an adjacent area (Sargeant 1981). However, vehicle collisions with waterfowl during Project Construction are likely to be minimal due to avoidance of wetlands and lakes to the extent practical, the slow-moving nature of most vehicles during Construction activities, and low population densities found throughout most areas.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Waterfowl may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be rare, the proposed mitigation is likely to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not likely to have a measurable effect on Waterfowl.

Summary of Likely Residual Environmental Effects

The likely residual environmental effects of Project Construction on Waterfowl are as follows:

- Adverse, because it will result in an alteration or loss of habitat, temporary sensory disturbances and the potential for collisions and incidental take during construction.
- Of low magnitude, because 1% or less of the wetland Waterfowl habitat available in the RSA is predicted to be intersected by the ROW. As a result, the Project is predicted to have little, if any, effect on regional Waterfowl populations. To be precautionary, mitigation regarding ROW alignment is not considered in this calculation.
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are likely to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA.

- Of medium-term to far future duration because, although many Construction-related effects (including sensory disturbances) are likely to be limited to the Construction period, the effects of habitat alteration or loss will be expressed throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association of the various species and a good understanding of the species' likely responses to Project interactions. In addition, the conservative assessment approach using the 20% contingency (i.e., precautionary approach), and Nalcor's commitment to applying the mitigation measures add confidence to the prediction.

12.5.5.4 Construction Effects: Passerines

Habitat Alteration or Loss

For Passerines, a key potential effect of Project Construction is alteration or loss of habitat associated with clearing of the access and ROW and construction of Project infrastructure. The anticipated effects related to alteration or loss of habitat are discussed in detail below for each of the key passerine species considered in this assessment. Critical habitat has not yet been defined for any *SARA*-listed species in the province.

Rusty Blackbird

Rusty Blackbird breed throughout the province, but are more common in Labrador. During the breeding season they prefer riparian areas in forested wetlands, but will utilize a diversity of habitats, including wetlands and riparian areas in cutovers, stream buffers untouched by fire in recent burns, treatment ponds in forested areas and the banks of hydroelectric reservoirs. However, their productivity in disturbed habitats is unknown (COSEWIC 2006, internet site). Adults feed mainly on wetland invertebrates but are considered opportunistic feeders (Warkentin and Newton 2009). Nests are built in riparian vegetation on the edges of wetlands or other bodies of water in May to June (Environment Canada 2009, internet site). The conversion of wetland forests on the wintering grounds of the Rusty Blackbird in the United States is thought to be the most important factor in the decline of this species, but habitat conversion in the southern part of the species' breeding range in Canada is also considered a contributing factor (COSEWIC 2006, internet site).

Table 12.5.5-3 indicates the predicted alteration or loss of primary habitat (i.e., wetland and scrub / heathland / wetland) as a result of Project Construction, by region, for Rusty Blackbird (based on the centre line ROW). The potential amount of primary habitat altered or lost for all regions, including the 20% contingency, is 20 km^2, representing approximately 4% of the primary habitat available within the LSA. Within the RSA, the amount of primary habitat predicted to be affected by the Project is <1% for all regions. Although primary habitat occurs in all regions, this species is considered uncommon on the Island and often transient (Warkentin and Newton 2009). Therefore, Table 12.5.5-3 reflects likely Project effects on available habitat, but does not consider occupancy. Regardless, the loss of primary habitat to Construction activities will likely have a small measurable effect on habitat availability at the local scale and little if any effect at the regional scale.

Mitigation in place for riparian zones, as described in Section 12.2.5 (Vegetation), will minimize effects on breeding sites for Rusty Blackbird. Because Rusty Blackbird have been shown to utilize a diversity of habitat types during the breeding season, including anthropogenically modified and disturbed ones (COSEWIC 2006, internet site), the estimated alteration or loss of habitat for this species as a result of Construction activities will likely be less than indicated.

Table 12.5.5-3 Primary Habitat for Rusty Blackbird Potentially Affected by Construction (By Region)

Region	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	145	19	1,198	21	4	3	<1
Northern Peninsula	148	30	1,255	31	6	4	<1
Central and Eastern Newfoundland	158	24	1,293	26	5	3	<1
Avalon Peninsula	105	43	797	45	5	4	<1

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.

Red Crossbill

Red Crossbill are highly specialized for conifer habitats. They generally prefer unlogged or mature forests that produce abundant cones, such as large, mature black spruce and balsam fir stands, and also red pine, white pine, and white spruce stands (Environment Canada 2009, internet site). In Newfoundland, sightings have been made in native red pine and eastern white pine stands, suggesting that these stands have been historically important to the species, and may be linked to their current survival (Environment Canada 2006). Red Crossbill nest in conifer trees and forage in large flocks (according to the availability of cones) (Environment Canada 2009, internet site). Although Red Crossbill has an association with mature coniferous forests, they have an irruptive behaviour and an ability to breed throughout the year in response to cone production. As such, habitat associations are difficult to identify (Environment Canada 2006).

While there are no records of Red Crossbill in Labrador (Environment Canada 2009, internet site), the potential range for this species, based on the distribution of mature coniferous forests, includes the Northern Peninsula, Central and Eastern Newfoundland and Avalon Peninsula regions (IFWD, n.d.). As indicated in the Recovery Strategy for the Red Crossbill (Environment Canada 2006), critical habitat under *SARA* and recovery and critical habitat as defined by the *NLESA* has not been described due to lack of knowledge regarding the subspecies existence, insular distribution and habitat associations. It also indicates that critical habitat is unlikely to be spatially mapped unless a nest is found. Rather, critical habitat would be managed at the landscape level through measures such as maintaining a percentage of the forest landscape with cone-bearing trees, which shifts spatially over time. The proposed clearing associated with this Project will not conflict with conservation measures for this species.

Based on data provided in Section 12.2.5 (Vegetation), effects of the Project are not likely to affect high proportions of particular habitat types that have capacity to support Red Crossbills. In particular, losses of Conifer Forest and Open Conifer Forest Habitat Types within all regions on the Island of Newfoundland are estimated to be less than 4% of that available in the LSA. Therefore, potential breeding habitat will exist in each region following the clearing of the ROW and construction of Project infrastructure.

Grey-cheeked Thrush

Grey-cheeked Thrush breed within both Labrador and Newfoundland. This species prefers dense, low coniferous forest for breeding, including young regenerating forest, open-canopy old growth forest with a dense shrub understorey, and dense, stunted spruce on windblown sites or near the tree line (Dalley et al. 2005). In Labrador, the species is found in mature coniferous stands and sparsely forested valleys (Todd 1963).

In western Newfoundland, a 1999 study found Grey-cheeked Thrush in mature forests 77 to 87 years old, and absent in younger stands from 40 to 73 years old (Thompson et al. 1999). Grey-cheeked Thrush are known to breed throughout Newfoundland and Labrador (NLDEC-W 2010), but were found to be relatively abundant on the Northern Peninsula during passerine surveys conducted for the Project (Stantec 2010f).

Although considered somewhat tolerant of clear-cutting, the loss of large proportions of forested habitat on a landscape scale is likely to negatively affect Grey-cheeked Thrush (NLDEC-W 2010). Large-scale displacement from habitat, may lead to increased inter-specific competition for resources with Swainson's Thrush, with which it shares considerable ecological overlap (Mack and Yong 2000, internet site). Table 12.5.5-4 summarizes the amount of primary (i.e., conifer forest, conifer scrub and mixedwood forest) habitat potentially altered or lost as a result of Project Construction by region for the Grey-cheeked Thrush, based on the centre line ROW. The potential amount of primary habitat altered or lost for all regions, including the 20% contingency, is 32 km^2, representing approximately 4% of available habitat within the LSA and less than 1% of the primary habitat available within the RSA, by region.

Table 12.5.5-4 Primary Habitat for Grey-cheeked Thrush Potentially Affected by Construction (By Region)

Region	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	355	46	2,489	43	13	4	<1
Northern Peninsula	178	37	1,392	34	7	4	<1
Central and Eastern Newfoundland	275	42	1,803	37	10	4	<1
Avalon Peninsula	62	25	467	27	2	3	<1

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.

Olive-sided Flycatcher

The Olive-sided Flycatcher is known to breed throughout Newfoundland and in portions of Central and Southeastern Labrador. It is primarily associated with natural and man-made edge habitats, including forest openings, forest edges, farmlands, cutovers, burns, riparian areas and wetland edges (Altman and Sallabanks 2000, internet site). These habitats are generally found adjacent to coniferous and mixed-coniferous forests and, in Canada, this species is also associated with open habitats of bogs, muskegs and swamps (Altman and Sallabanks 2000, internet site). Given their primary association with specific and localized riparian and edge habitats, habitat quality indices for Olive-sided Flycatcher have not been mapped in this EA.

Given this species' association with edge habitat, clearing associated with the Project is not necessarily representative of a loss of habitat. However, there is evidence that the breeding success of birds nesting in harvested habitats is lower than the breeding success of birds nesting in natural (e.g., burned) openings (COSEWIC 2007a, internet site). Robertson and Hutto (2007) present evidence that harvested landscapes harbour more nest predators, resulting in significantly greater egg and nestling loss for birds nesting in these areas. Given the linear configuration of the Project, generally low amounts of any habitat type within the LSA will be affected by construction activities. Additionally, mitigation in place for riparian zones, as described in Section 12.2.5 (Vegetation), will limit the effects of the Project on breeding habitat for the Olive-sided Flycatcher.

Blackpoll Warbler

In Northern Canada, Blackpoll Warblers are primarily associated with coniferous forests (Hunt and Eliason 1999, internet site) and they are relatively abundant within both the Central and Southeastern Labrador region, as well as throughout Newfoundland. Breeding records indicate some use of wetland habitats (i.e., spruce bogs or conifer swamps) at elevations ≥700 m (Walley 1989; Gross 1994). Based on analyses of the Breeding Bird Survey data set, there is a long-term decline in the population in Newfoundland (–7.0%, p <0.001) (Hunt and Eliason 1999, internet site). This same decline is not as marked throughout the remainder of the range (Hunt and Eliason 1999, internet site). Preferred habitats in Newfoundland are damp coniferous forests rich in lichens, and headlands and barrens with tuckamore (Warkentin and Newton 2009). Individuals prefer small, stunted trees for nesting, mainly in open or recently cleared areas (Warkentin and Newton 2009; Hunt and Eliason 1999, internet site).

Table 12.5.5-5 summarizes the primary habitat (i.e., conifer scrub, cutover and open conifer forest, as well as wetland and scrub / heathland / wetland habitat in some Ecoregions) potentially altered or lost as a result of Project Construction by region for Blackpoll Warbler. The potential amount of primary habitat altered or lost for all regions, assuming the centre line ROW and a 20% contingency, is 35 km^2. This predicted alteration or loss of habitat due to the Project represents 4% of available primary habitat within the LSA and less than 1% of available primary habitat within the RSA potentially affected, by region.

Table 12.5.5-5 Primary Habitat for Blackpoll Warblers Potentially Affected by Construction (By Region)

Region	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	349	4	2,397	42	14	4	<1
Northern Peninsula	196	40	1,731	43	8	4	<1
Central and Eastern Newfoundland	217	33	1,660	34	8	4	<1
Avalon Peninsula	118	48	773	44	5	4	<1

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.

Wetland Sparrows

The wetland sparrow guild includes four species: Swamp Sparrow, Song Sparrow, Lincoln's Sparrow and Savannah Sparrow. Moisture, tree density, ground vegetation density and habitat area are factors that define habitat suitability for this group (Wheelwright and Rising 2008; Arcese et al. 2002, internet site; Mowbray 1997; Ammon 1995). The degree of tree cover is also important, as all four species generally prefer open areas. Nesting sites are generally close to the ground in areas that provide adequate shelter and access to foraging sites (Wheelwright and Rising 2008; Arcese et al. 2002, internet site; Mowbray 1997; Ammon 1995).

Studies have demonstrated that wetland sparrow populations are often sensitive to habitat modifications. For example, reproductive success of the Savannah Sparrow has been shown to be lower in disturbed habitats, to the extent that such areas become dependent on immigration from other sources to maintain their population (Wray et al. 1982). Similarly, when the quality of Song Sparrow habitats are compromised to the extent that nest failure for this species exceeds 50%, their abundance declines unless supplemented by immigration (Arcese et al. 2002, internet site). Should habitat loss displace wetland sparrows, population densities in alternate habitats may become higher than usual, and this can lead to increased competition for resources. For example, Song Sparrow success is closely linked to the availability of food and nesting habitat (Arcese et al. 2002, internet site), suggesting a susceptibility to competition-induced stress. Furthermore, natural predators are a key cause of mortality for wetland sparrows, with corvids being particularly active in searching for nests (Wheelwright and Rising 2008). As a result, habitat disturbances that attract corvids have the potential to result in increased predation pressure on breeding sparrows.

Table 12.5.5-6 summarizes the potential alteration or loss of primary habitat (i.e., wetlands and scrub / heathland / wetland) as a result of Project Construction by region for wetland sparrows, assuming the centre line ROW. The potential amount of primary habitat altered or lost for all regions, including the 20% contingency, is 20 km^2, representing 4% of available primary habitat within the LSA, and less than 1% of available primary habitat with the RSA, by region. However, disturbance to wetland habitats is likely to be less, as construction activities will generally avoid these habitats where possible, and vegetation clearing will be minimal within wetlands as a result of the often low-lying character of their vegetation. Furthermore, mitigation in place for wetlands and riparian zones, as described in Section 12.2.5 (Vegetation), will minimize effects on breeding sites for wetland sparrows.

Table 12.5.5-6 Primary Habitat for Wetland Sparrows Potentially Affected by Construction (By Region)

Region	Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	145	19	1,198	21	4	3	<1
Northern Peninsula	148	30	1,255	31	6	4	<1
Central and Eastern Newfoundland	158	24	1,290	26	5	3	<1
Avalon Peninsula	105	43	797	45	5	4	<1

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.

Although not captured at the scale of the ELC, riparian areas are also considered primary wetland sparrow habitat. Data on the distribution and abundance of riparian habitat, provided in Section 12.2.5 (Vegetation), indicate that the proportion of riparian shoreline within the LSA that is potentially intersected by the ROW is 6% within the Central and Southeastern Labrador, Northern Peninsula, and Avalon Peninsula Regions, and 7% within Central and Eastern Newfoundland. This will be further reduced as Nalcor will limit the amount of riparian shoreline alteration to the extent practical by routing of the ROW to avoid large waterbodies and rivers (and their associated shoreline). Within PPWSAs, appropriate riparian buffers will be maintained undisturbed on waterbodies as prescribed in the Policy for Land and Water Related Developments in Protected Public Water Supply Areas (NLDEC 1999, internet site). Further to this, waterbodies within non-PPWSAs will have a minimum buffer width of 20 m.

Sensory Disturbance

The sensitivity of Passerines to sources of sensory disturbance will vary considerably depending on the species and the timing and nature of construction activities. For example, Lincoln's Sparrow is known to exhibit increased rates of nest desertion in areas with moderate to high levels of human activity (Ammon 1995), while other species, such as Song Sparrow, are tolerant of human presence (Arcese et al. 2002, internet site). Because construction noise is estimated to be at ambient levels at a maximum distance of 1 km depending on-site conditions, there is the potential for passerines throughout the LSA to be exposed to elevated noise levels, although such exposure will be temporary and localized as construction activities move along the ROW.

Direct and Indirect Mortality

Passerines are known to be particularly susceptible to vehicle collisions (Erickson et al. 2005), likely due to their small size and low-flying behaviour. Elevated risks of mortality may occur where roads pass through the primary habitats of species that forage on or near the ground, such as Grey-cheeked Thrush and Rusty Blackbird. However, passerine collisions with vehicles during the Project are likely to be minimal due to the slow-moving nature of most vehicles during Construction activities within the Project components.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Passerines may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited, the proposed mitigation is expected to limit the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not expected to have a measurable effect on Passerines.

Summary of Likely Residual Environmental Effects

The likely residual environmental effects of Project Construction on Passerines are predicted to be as follows:

- Adverse, because there will be a decrease in habitat, sensory disturbances and the potential for collisions and incidental take during Construction.
- Of low magnitude, because less than 1% of the primary habitat available for passerines in the RSA is predicted to be intersected by the ROW. As a result, the Project is likely to have little if any effect on regional Passerine populations.
- Limited to the RSA, since physical disturbance of habitat will be limited to the LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA and noise and associated disturbance will likely extend into the RSA.
- Of medium-term to far future duration because, although many Construction-related effects (including sensory disturbances) are likely to be limited to the Construction period, the effects of habitat alteration or loss will be expressed throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association of the various species and a good understanding of the species' responses to Project interactions. In addition, the conservative assessment approach using the 20% contingency (i.e., precautionary approach), and Nalcor's commitment to applying the mitigation measures add confidence to the prediction.

12.5.5.5 Construction Effects: Raptors

Habitat Alteration or Loss

Osprey

Osprey breed throughout Newfoundland and Labrador, but their habitat requirements vary between the regions. Within Labrador they tend to nest within 3 km of a waterbody (average of 435 m), at the top of dominant or co-dominant white or black spruce, and adjacent to smaller tributary streams or islands (Jacques Whitford 1995). Nests are located 1 to 3 m from the tops of trees with an open aspect for easy access (Jacques Whitford 1999). Artificial structures, such as transmission towers, are also used, where available. On the Island, Ospreys tend to nest on the coast, where shallow bays provide abundant, easily seen groundfish (J. Brazil pers.

comm., cited in Jacques Whitford 1999). Gosse and Montevecchi (2001) associated adult Osprey with young second growth and uncut old growth balsam fir habitats near large waterbodies in western Newfoundland.

To minimize effects on Osprey, once the final alignment of the ROW has been determined, the route will be surveyed in advance of construction to identify any active nests. This will allow for replacement of the nest by an artificial structure, if appropriate. This measure would be implemented in consultation with the NLDEC Wildlife Division. Approved raptor protection procedures (e.g., delayed clearing within 800 m of an active raptor nest until the nest the nest is no longer occupied, no camps within 800 m of an active nest) will apply while working in and around any identified nests. Setback distances will exist during construction for personnel and equipment near active nests, and are based on reviews of raptor sensitivity to disturbances (e.g., Ruddock and Whitfield 2007; Richardson and Miller 1997). Clearing will not occur within 800 m of an active raptor nest during the nesting period (May 15 to July 31) and within 200 m of an active raptor nest during the non-nesting season. Furthermore, crews will not establish a permanent or temporary camp within 800 m of an active raptor nest. Other Construction-related activities will also be limited within 200 m of active nests.

Bald Eagle

Bald Eagle also breed throughout Newfoundland and Labrador and are generally less common than Osprey. They typically nest in forested habitats, particularly mature and old growth forests, that are generally close (<2 km) to large bodies of water (Buehler 2000, internet site). Within Labrador, they tend to nest in trees adjacent to smaller tributary streams, particularly in large eastern larch or white birch (Minaskuat Limited Partnership 2005b). In Newfoundland, nests are located high in deciduous or coniferous trees or occasionally on cliffs along the coast, or in forested areas near lakes and ponds (Warkentin and Newton 2009).

Important micro-habitat features favoured by both these tree nesting Raptors (i.e., Bald Eagle and Osprey) are not distinguishable at the level of the ELC (Nalcor 2009). However, intensive studies since the early 1990s, particularly for Labrador, have resulted in an extensive inventory of nest locations that provide insight on specific areas of primary habitat. For example, data indicates that within the RSA there are high concentrations of Bald Eagle nests along the Trinity and Placentia Bay coastlines at the western end of the Avalon Peninsula (ACCDC 2010, internet site; ACCDC 2008, internet site).

To minimize effects on Bald Eagle, once the final alignment of the ROW has been determined, the route will be surveyed in advance of Construction to identify any active nests. This will allow for replacement of the nest by an artificial structure, if appropriate. This measure would be implemented in consultation with the NLDEC Wildlife Division. Approved Raptor protection procedures (e.g., delayed clearing within 800 m of an active raptor nest until the nest the nest is no longer occupied, no camps within 800 m of an active nest) will apply while working in and around any identified nests. Setback distances will exist during Construction for personnel and equipment near active nests, and are based on reviews of Raptor sensitivity to disturbances (e.g., Ruddock and Whitfield 2007; Richardson and Miller 1997). Clearing will not occur within 800 m of an active Raptor nest during the nesting period (May 15 to July 31) and within 200 m of an active Raptor nest during the non-nesting season. Furthermore, crews will not establish a permanent or temporary camp within 800 m of an active raptor nest. Other Construction-related activities will also be limited within 200 m of active nests.

Short-eared Owl

In Newfoundland and Labrador, Short-eared Owl are associated with tundra, coastal barrens, sand dunes and field and bog habitats (Schmelzer 2005). Throughout its range, this species prefers open fields for feeding and nesting (Warkentin and Newton 2009). Short-eared Owl are nomadic, and wander throughout their range looking for prey consisting primarily of small mammals, insects and other birds (Schmelzer 2005). Nests are flattened depressions in the ground, typically hidden under low shrubs, reeds and grasses near water. Within the RSA, records indicate that this species is most abundant in the coastal barrens along the Strait of Belle Isle (including both the Labrador and Newfoundland sides) and to a lesser extent in the Avalon Peninsula (ACCDC 2010, internet site; ACCDC 2008, internet site; Schmelzer 2005; AGRA Earth and Environmental Ltd. and Harlequin Enterprises 1999; Jacques Whitford 1999).

Habitat loss is considered the main factor affecting the population of Short-eared Owl in other parts of its range (Schmelzer 2005). However, the amount of suitable habitat available to them in Newfoundland and Labrador has remained largely unchanged over the past century, suggesting that its population within the province may occur at historical levels in the absence of other important limiting factors (Schmelzer 2005). In addition to the loss of habitat, declines in Short-eared Owl populations have been attributed to increased nest depredation as a result of habitat fragmentation, declines in prey abundance as a result of habitat changes, and other factors (Schmelzer 2005).

Table 12.5.5-7 summarizes the potential amount of alteration or loss of primary (alpine vegetated, kalmia lichen / heathland and lichen heathland habitats) as a result of Project Construction by region for Short-eared Owl. The potential amount of primary habitat altered or lost for all regions, assuming the centre line ROW plus the 20% contingency is approximately 3 km^2. This predicted alteration of loss represents up to 5% of available habitat within the LSA and 3% or less of the available primary habitat within the RSA, by region. Disturbance to wetland habitats (i.e., secondary habitat) are likely to be limited as construction activities will generally avoid these areas where possible and vegetation clearing will be minimal within many wetlands as a result of the often low-lying character of their vegetation.

Table 12.5.5-7 Primary Habitat for Short-eared Owl Potentially Affected by Construction (By Region)

Region	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	44	6	341	6	2	3	<1
Northern Peninsula	2	<1	35	<1	<1	3	3
Central and Eastern Newfoundland	8	1	56	1	<1	5	2
Avalon Peninsula	15	6	76	4	1	5	1

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.

Sensory Disturbance

Osprey show a wide range in tolerance to human disturbance (Ruddock and Whitfield 2007). In much of its range, Osprey nest close to human activity and appear unaffected by moderate levels of disturbance (Vana-Miller 1987). However, there is also evidence to suggest that individuals nesting in areas away from human activity are adversely affected by disturbance, which may result in lower reproductive success (Van Daele and Van Daele 1982). Disturbance is least tolerated during incubation and early nestling (compared to nest initiation) (Trimper et al. 1998a; Levenson and Koplin 1984). Sensory disturbance from human activity can have an adverse environmental effect if it prompts adults to flush from the nest sufficiently often or long enough to jeopardize the survival of eggs or young, thus exposing them to weather or increasing their vulnerability to predators.

The sensitivity of Bald Eagle to human activities varies among the phases of their nesting period. They are most sensitive to human disturbance during the courtship and nest building phase and disturbance during this period is typically manifested in nest abandonment (USFWS 2010, internet site). They are also sensitive during the egg laying, incubation and hatching, and late nestling periods, and considered moderately sensitive during the early nestling period (USFWS 2010, internet site). They may respond in a variety of ways when they are disturbed by human activities. For example, they may inadequately construct or repair their nest, or may abandon the nest, both of which can lead to failed nesting attempts. During the incubation and hatching period, human activities may startle adults or cause them to flush from the nest, which may lead to the direct damage of eggs or injured young, or otherwise jeopardize their health or lead to increased risk of predation, depending on the length of the absence and environmental conditions (USFWS 2010, internet site). However, their sensitivity also varies among individuals within each reproductive phase. For example, some pairs nest successfully near human activity, while others abandon nest sites in response to activities much farther away. Such variability is likely attributable to a number of factors, including visibility of the activity, its duration and noise level, extent of the area affected by the activity, the eagle pair's prior experiences with humans, and tolerance of the individual nesting pair (USFWS 2010, internet site).

Despite variability in the tolerance of these or other raptors to human activity, they are generally considered to be sensitive to human activities. As such, a variety of avoidance and other mitigative measures will be practiced during the Construction Phase of the Project to limit disturbance to this KI. As noted previously, the location of Bald Eagle, Osprey, Short-eared Owl or other Raptor nests will be determined through a pre-Construction survey, and clearing in these locations will be delayed until the nest is no longer occupied. If this is not possible, mitigation involving artificial nests will be implemented, in consultation with the NLDEC Wildlife Division. Additionally, only essential vehicular activity, including helicopter flights, and essential machinery and equipment will be permitted along the ROW and travel routes to minimize disturbance. Also, work will not be conducted within 200 m of an active raptor nest unless in consultation with the NLDEC Wildlife Division, and permanent or temporary camps will not be established within 800 m of active raptor nests.

Direct and Indirect Mortality

Raptors are generally not as susceptible to vehicle collisions as other bird groups (Erickson et. al. 2005), although they have been documented to be vulnerable in some areas. For example, a study which examined driving surveys over a 10-year period in New Jersey estimated that 25 raptors were killed per year within a 145 km survey route along roads, with most fatalities being of owls (Loos and Kerlinger 1993). Due to their feeding and habitat requirements, vehicle collisions with Bald Eagle and Osprey are not anticipated. For example, Osprey generally fly low only when diving for prey in waterbodies (Poole 1989). However, collisions involving other raptor species are possible, as collisions with aircraft and cars have been documented as a source of accidental mortality for the Short-eared Owl (Cadman and Page 1994). However, collisions rates are likely to be minimal due to the general ecology and behaviour of Raptor, as well as the slow-moving nature of most vehicles during Construction activities, and adherence to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Raptors may result in alteration or loss of habitat types, or potentially nests. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be small in scale, the effect is likely to be limited. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not expected to have a measurable effect on Raptors.

Summary of Likely Residual Environmental Effects

The likely residual environmental effects of Project Construction on Raptors are as follows:

- Adverse, because there will be a decrease in habitat, temporary sensory disturbances and potential for collisions and incidental take during Construction.
- Of low magnitude, because less than 1% of the primary habitat available for raptors in the RSA is predicted to be intersected by the ROW. The combined effects of habitat loss or alteration, sensory disturbance and sources of mortality during the most sensitive periods (i.e., breeding, nesting and rearing) are predicted to have little effect on regional Raptor populations.

- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are likely to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA.
- Of medium-term to far future duration because, although many Construction-related effects (including sensory disturbances) are likely to be limited to the Construction period, the effects of habitat alteration or loss will be expressed throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association of the various species and a good understanding of the species' responses to Project interactions. In addition, the conservative assessment approach using the 20% contingency (i.e., precautionary approach), and Nalcor's commitment to applying the mitigation measures add confidence to the prediction.

12.5.5.6 Construction Effects: Upland Game Birds

Habitat Alteration or Loss

Ruffed Grouse

In general, logging, agriculture and other disturbances have favoured Ruffed Grouse by allowing the establishment and growth of early succession trees. However, as the scale of these habitat changes increases, the environmental effect can become adverse in cases where inadequate quantities of higher quality forest fragments remain (Rusch et al. 2000). There is no consensus about the minimum threshold of local and regional forest cover necessary for population maintenance. Wiggins et al. (2006, internet site) concluded that low densities of Ruffed Grouse populations in the Rocky Mountain Region could be attributed to a regional decrease in aspen habitat, which in turn resulted from a reduction in disturbance factors (e.g., active suppression of wildfires and reduced logging programs) that help to regenerate aspen.

In Labrador, Ruffed Grouse are concentrated in deciduous, and particularly aspen dominated forest (Minaskuat Inc. 2008a). Deep snow cover without a crust is critical in winter for shelter, as are small buds and flowers of deciduous groundcover for foraging. It has been estimated that appropriate habitat for Ruffed Grouse covers less than 1% of Labrador's land area (Northland Associates Limited 1980). The two records of this species in the Study Area in Central and Southeastern Labrador during passerine and ELC surveys in 2008 were in hardwood and wetland habitats (Minaskuat Inc. 2008a, b). The latter may contain willows and other shrubs that can provide an important supplementary food source.

In Newfoundland, preferred habitat is identified as second-growth deciduous and mixed forests, particularly with abundant birch or aspen (Warkentin and Newton 2009). The one observation of this species in the Study Area in Newfoundland during passerine surveys in 2008 was associated with mixedwood habitat. Evidence of their presence was also documented in conifer forest habitat during ELC surveys (Stantec 2010b).

Primary habitat for Ruffed Grouse was defined as hardwood forest. Primary habitat was exclusive to the Labrador portion of the RSA (Stantec 2010b) and is not present within the LSA for Labrador. As such, it is unlikely that primary habitat will be affected by Project Construction.

Willow Ptarmigan

Willow Ptarmigan are year-round residents of Newfoundland and Labrador and are generally associated with low-lying tundra, especially in thickets of willow and alder during the breeding season. However, they often undergo large seasonal migrations, especially in Labrador, where they are suspected of migrating many hundreds of kilometres for winter shelter. Because such habitat is abundant in some areas of Newfoundland, movements of Willow Ptarmigan there are generally less than in Labrador. On the Island of Newfoundland, they are most common on the Avalon Peninsula, along the Maritime Barrens, near the tips of large peninsulas and in association with open upland sites (Warkentin and Newton 2009).

The specific habitat requirements and large seasonal movements of Willow Ptarmigan make it difficult to assess the effects of the Project on their habitat. However, because they are generally found in tundra ecosystems during the breeding season, they are considered to be most likely associated with the kalmia lichen / heathland, lichen heathland, and scrub / heathland / wetland ELC Habitat Types. Based on data provided in Section 12.2.5 (Vegetation) and the assumed centre line ROW and 20% contingency, the Project is expected to affect low proportions (i.e., <5%) of almost all of these particular habitat types within any given region. The exception is kalmia lichen / heathland habitat on the Northern Peninsula, where 6% of the approximately 1 km^2 area for this habitat within the LSA may be affected by construction activities. However, because scrub / heathland / wetland is much more prominent in this region (i.e., approximately 108 km^2 of the region), effects on Willow Ptarmigan habitat are likely to be low. Additionally, due to the low-lying vegetation, clearing is expected to be likely within habitats that support Willow Ptarmigan.

Sensory Disturbance

Ruffed Grouse or Willow Ptarmigan, as well as other upland game birds, will likely experience some sensory disturbance associated with construction activities. Although noise tolerance thresholds for these species are not known, neither are highly sensitive to human activity and are likely to be tolerant of elevated noise levels as long as appropriate visual cover is present. Ruffed Grouse are particularly tolerant of human activities and are known to reside in close proximity to active infrastructure such as roadways. Construction noise is estimated to be at ambient levels at a maximum distance of 1 km.

Direct and Indirect Mortality

The low-flying nature of upland game species contributes to their relative susceptibility to vehicle collisions. Mortality of Ruffed Grouse or Willow Ptarmigan are most likely to occur where roads are adjacent to primary succession vegetation, and is expected to be highest during fall when juveniles are dispersing. However, vehicle collisions with upland game birds vehicle are likely to be minimal due to the slow-moving nature of most vehicles during Construction activities.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Upland Game Birds may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be small, the proposed mitigation is likely to minimize the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not likely to have a measurable effect on Upland Game Birds.

Summary of Likely Residual Environmental Effects

The likely residual environmental effects of Project Construction on Upland Game Birds are as follows:

- Adverse, because Upland Game Birds will be exposed to sensory disturbances and the potential for incidental take during Construction, although Ruffed Grouse and Willow Ptarmigan may benefit from a promotion of early successional vegetation due to clearing activities.
- Of low magnitude, because little of the available primary habitat is expected to be altered (no primary habitat for Ruffed Grouse) within the RSA. The combined effects of habitat loss or alteration, sensory disturbance and sources of mortality during the most sensitive periods (i.e., breeding, nesting and rearing) are predicted to have little effect on regional Upland Game Bird populations.
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA.
- Of medium-term to far future duration because although many Construction-related effects (including sensory disturbances) are expected to be limited to the Construction period, the effects of habitat alteration or loss will be expressed throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association of the various species and a good understanding of the species' responses to Project interactions. In addition, the conservative assessment approach using the 20% contingency (i.e., precautionary approach), and Nalcor's commitment to applying the mitigation measures add confidence to the prediction.

12.5.5.7 Construction Effects: Other Species of Special Conservation Status

Habitat Alteration or Loss

Red Knot

Red Knot are not known to breed in Newfoundland and Labrador, but do stopover during their southward migration in the fall. While there are no known important areas for Red Knot in Labrador or on the Island of Newfoundland, they may occur in small numbers in the Study Area. Red Knot have been reported in relatively large numbers on the beaches of the Northern Peninsula in recent years (CWS unpublished data). During migration they have been recorded along coastal areas, mostly on shorelines, sandflats, and salt marshes around the province, and have been observed to frequently utilize Bellevue Beach (Garland and Thomas 2009), which is within the RSA of the Avalon Peninsula region. However, Bellevue Beach along with other locations where Red Knot has been recorded are outside the extent of the LSA. As such, Construction activities associated with the Project are not likely to interact with this species.

Common Nighthawk

Common Nighthawk breeds in Labrador, but is rare, if present at all, on the Island of Newfoundland (Environment Canada 2009, internet site). This species prefers open, vegetation-free habitats including dunes, beaches, recently harvested or burned forests, rocky outcrops, rocky barrens, grasslands, pastures, peat bogs, marshes, lakeshores and river banks (Poulin et al. 1996, internet site), as well as mixed and coniferous forests (Environment Canada 2009, internet site). The Common Nighthawk is an aerial insectivore, feeding at dusk and dawn on flying ants and coleopterans (Environment Canada 2009, internet site). Because it is a territorial species that requires large areas in response to reduced habitat quality, local effects to its habitat can be reflected at the regional level (Poulin et al. 1996, internet site).

Primary habitat is that which provides shelter and food sources for all stages of the lifecycle. Dry black spruce / lichen habitat was identified as particularly important habitat for this species in Labrador (Minaskuat Inc. 2008c). For the purposes of the habitat mapping conducted in support of this EA, primary habitat was identified as cutover, burn, open conifer and black spruce lichen habitats. Secondary habitat includes some combination of feeding, protection, nesting and resting sites. For the Common Nighthawk in Labrador, this includes riparian shoreline vegetation and wetlands, including marshes, fens and bogs.

Table 12.5.5-8 summarizes the likely alteration or loss of primary habitat as a result of Project Construction by region for Common Nighthawk. The likely amount of primary habitat altered or lost for all regions, estimated by the centre line ROW including 20% contingency, is 9 km^2, representing 4% of available habitat within the LSA and less than 1% within the RSA. Note that the likely amount of primary habitat altered or lost due to construction activities would be lower as only certain cutover and burn habitats (i.e., within regenerating forests) would be preferred by this species. Additionally, because Common Nighthawk are known to utilize cutovers, vegetation clearing for the various Project components could create habitat for this species.

Table 12.5.5-8 Primary Habitat for Common Nighthawk Potentially Affected by Construction (By Region)

Region	Primary Habitat Within the LSA		Primary Habitat Within the RSA		Primary Habitat Within the ROW		
	(km^2)	(%)	(km^2)	(%)	(km^2)	(% of Available Habitat in the LSA)	(% of Available Habitat in the RSA)
Central and Southeastern Labrador	214	28	1,536	27	9	4	<1
Northern Peninsula	—[a]	—	—	—	—	—	—
Central and Eastern Newfoundland	—	—	—	—	—	—	—
Avalon Peninsula	—	—	—	—	—	—	—

Note: Rounding errors less than 1% may occur in final totals. ROW calculations include the 20% contingency.
[a] "—" values not provided because the Common Nighthawk is extremely rare, if present at all, on the Island of Newfoundland.

Sensory Disturbance

Migratory stopover locations for the Red Knot are located outside of the LSA and as noise levels are estimated to be at ambient levels at a maximum distance of 1 km from the source, individuals are not likely to experience sensory disturbance associated with Project Construction.

Although the threshold noise threshold noise level that elicits a response for Common Nighthawk is not known, this species will likely experience sensory disturbance, in the unlikely event that it is encountered.

Direct and Indirect Mortality

During migration, Red Knot congregate in large groups in traditional staging areas, which make them potentially more vulnerable to disturbance, pollution, and loss of resources than other species of shorebirds (COSEWIC 2007b, internet site). However, as discussed previously, the migratory stopover locations for this species are located outside of the LSA, and no interaction between Red Knot and Construction activities is likely to occur. Additionally, Newfoundland and Labrador has a lower population density compared to some other migratory stopover locations. According to local bird experts, there are few if any, threats to this species within the province that would cause any substantial decrease in their numbers (Mactavish pers. comm.; Whitaker, pers. comm., cited in Garland and Thomas 2009).

Among other factors, such as decreases in prey base and nest predation, some suggest that the decline of the Common Nighthawk may be partly attributable to vehicle collisions (Savignac 2007, internet site; Iron and Pittaway 2000). However, collisions with terrestrial vehicles during Project Construction are expected to be minimal due to the slow-moving nature of most vehicles during construction activities within the Project components. Nighthawks are also known to collide with aircraft and relatively high mortality rates have been reported during fall migration at some sites (Cumming et al. 2003). Interactions with aircraft are expected to be minimal, as helicopters may be used to move equipment or materials, depending on the terrain and site-specific conditions.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, release of drilling mud, multiple tower failure, localized slope failure, waste spill) on Species of Special Conservation Status may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be minimal, the proposed mitigation is likely to minimize the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not expected to have a measurable effect on avian Species of Special Conservation Status.

The residual environmental effects of Project Construction on other Species of Special Conservation Status are predicted to be as follows:

- Adverse, because there will be a decrease in habitat, sensory disturbances and potential for collisions and incidental take during Construction.
- Of low magnitude, because less than 1% of the primary habitat available for common nighthawk in the RSA is predicted to be intersected by the ROW, which are unlikely to interact with migratory stopover locations for Red Knot. The combined effects of habitat loss or alteration, sensory disturbance and sources of mortality during the most sensitive periods (i.e., breeding, nesting and rearing) are predicted to have little effect on regional populations of other Species of Special Conservation Status.
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA and noise and associated disturbance will likely extend into the RSA.
- Of medium-term to far future duration because although many Construction-related effects (including sensory disturbances) are expected to be limited to the Construction period, the effects of habitat alteration or loss will be expressed throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association of the various species and a good understanding of the species' responses to Project interactions. In addition, the conservative assessment approach using the 20% contingency (i.e., precautionary approach), and Nalcor's commitment to applying the mitigation measures add confidence to the prediction.

12.5.6 Operations and Maintenance

12.5.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

During the Operations and Maintenance phase of the Project, vegetation management, equipment maintenance and repairs, and inspections of the transmission system will interact with Avifauna when and where the activity occurs, with seasonal considerations (i.e., repairs done in the winter would interact with fewer species and when they are generally less sensitive to disturbance). Transmission line inspections will be conducted annually, on a rotational basis, with portions of the line scheduled for inspection each year. Inspections of the on-land transmission line may be completed from the air or from the ground. Ground-based inspections will be conducted using all-terrain vehicles (ATVs) during summer and snowmobiles in the winter, and aerial inspections will be conducted by helicopter. The Strait of Belle Isle crossing infrastructure and the shoreline electrode permeable berms will be inspected by ROV. Surface disturbances resulting from Operations and Maintenance activities, including major system repairs, will be contained within the Project components (e.g., converter stations, shoreline electrode sites, ROW and access roads), so the effects on habitat would be similar to those experienced during Construction, but limited to the specific location of the repairs and areas that were previously disturbed. The same types of mitigation will be applied to system repairs as committed to for Project Construction.

Vegetation management will commence in year eight of operations and repeated every seven years thereafter, or as required for safety. Vegetation management will be accomplished through an integrated approach, using a variety of methods (i.e., chemical and mechanical) and equipment. Vegetation management could result in sensory disturbance and incidental take if activities were to occur during the breeding season and affect birds that may have nested within and / or along the ROW or other Project components.

Interactions with Project Infrastructure

The presence and operation of transmission lines have the potential to result in the mortality of Avifauna through collisions and electrocutions of individuals. The potential for this type of event depends on a number of factors including the design of the towers, time of year, topography, habitat, bird species and bird population densities. According to the Avian Power Line Interaction Committee (APLIC), the effect of any particular power line can vary between species and among seasons within a single species, depending on the way adjacent habitat is used for feeding, roosting, courtship, nesting or brood rearing (APLIC 1994). Whether or not, and how often, birds in flight must cross a power line within their daily use areas will affect the risk potential for collisions and electrocutions. Problems can occur in specific situations where certain factors exist to create high collision or electrocution potential. For example, land use, topography, vegetation, wind patterns, and line placement are all factors that may contribute to increased collisions risk (APLIC 1994). Larger groups of Avifauna, such as Waterfowl, are relatively susceptible to collisions with transmission lines whereas raptors, particularly eagles, have the greatest potential for electrocution due to their large size and tendency to use transmission infrastructure for roosting and / or nesting opportunities.

Electrocutions

Birds that are attracted to power lines may be electrocuted when there is inadequate separation between energized conductors or energized conductors and grounded hardware. Most electrocutions occur on medium-voltage distribution lines (4 to 34.5 kilovolts (kV)), in which the spacing between conductors may be small enough to be bridged by birds (APLIC and USFWS 2005). Poles with energized hardware, such as transformers, can be especially hazardous, even to small birds, as they contain numerous, closely-spaced energized parts. Structures considered to be “avian-safe” are those that provide adequate clearances for large birds between energized and / or grounded parts. In the United States, 60 inches of horizontal separation to accommodate the wrist-to-wrist distance of an eagle, and 48 inches of vertical separation to accommodate the height of an eagle, are used as the standard for raptor protection (APLIC and USFWS 2005). However, in certain areas, such as those having concentrations of wading birds, vertical separation may need to be increased to 60 inches. Because dry feathers act as insulation, contact must be made between fleshy parts, such as the wrists, feet, or other skin, for electrocution to occur (APLIC and USFWS 2005).

Avian electrocution is not considered a risk on high voltage transmission lines because the design is typically sufficient to prevent birds from bridging the gap between grounded and conducting equipment. The clearance between grounded and conducting equipment on the proposed transmission towers for the Project is larger than the maximum wing span of birds found within the LSA. For example, most structures will have 30-40 glass or porcelain insulators per conductor, which will provide a vertical distance of approximately 4 m between energized conductors and grounded hardware. Horizontal distances between energized conductors is expected to be approximately 10 m, and the distance between an energized conductor and the optical overhead groundwire, and the energized conductor and the ground are both in the range of 7-8 m. As such, tower designs will be more than sufficient to prevent even the largest of raptors from bridging the gap between the energized conductors or energized conductors and grounded hardware (e.g., maximum wingspans for Bald Eagle are approximately 2.5 m, 2 m for Osprey, and 1 m for Short-eared Owl).

Avian electrocution is typically a greater risk on lower voltage transmission systems and distribution systems because the clearances between electrical components are smaller, making it possible for birds to contact two conducting elements or one grounded and one conducting element at the same time. The Project may include two such lines in association with shoreline electrodes at L’Anse au Diable in Labrador and Dowden’s Point in Conception Bay in Newfoundland, and these are expected to be approximately 400 km and 15 km in length, respectively. The electrode power lines will carry small unbalanced currents between the poles normal Project operations. During this time, voltage is anticipated to be so low as to not pose a threat of mortality to avifauna via electrocution. These lines would only be used to provide a return path for the full current in limited circumstances. Normally, it is anticipated that full current electrode use would amount to less than 40 hours per year, or at most a few days per year if major equipment replacement is required. The longest potential period of full current use would be in the event of an extended cable repair at the marine crossings of the Strait of Belle Isle. The Project will be designed and operated to avoid the potential for such an occurrence. However, should the electrode lines be needed to carry a full current, they would pose threats of electrocution similar to standard distribution lines.

Collisions

The risks of Avifauna collision with power lines are dependent on the species involved, the character of the environment, and the configuration and location of the lines. Species-related factors include habitat use, body size, flight behaviour, age, sex, and flocking behaviour (APLIC and USFWS 2005). Heavy-bodied, less agile birds or those within large flocks may lack the ability to quickly respond to obstacles, and they are therefore generally more likely to collide with power lines. Birds that are inexperienced or are distracted (e.g., by territorial or courtship activities) have a greater potential for collisions.

Environmental factors influencing collision risk include the effects of weather and time of day on the visibility of the line, surrounding land use practices that may attract birds, and human activities that may flush birds into lines. Line-related factors influencing collision risk include the configuration and location of the line and line placement with respect to other structures or topographic features (APLIC and USFWS 2005). Overhead ground wires that provide shielding from lighting strikes are of a smaller diameter than the conductor lines themselves, are believed to be more difficult for birds to see, and are considered the major cause of bird collisions with power lines (APLIC 1994).

In general, nocturnal migrants (i.e., passerines) are high-flyers and are not prone to collision during flight. Generally, the flight heights of diurnal migrants (i.e., waterfowl, waterbirds, raptors) vary more than those of nocturnal migrants. However, waterfowl are the species group most susceptible to wire collision (Erickson et al. 2001), and are likely to be flying higher than the height of the proposed towers unless there are distinct features to draw them in (i.e., wetlands, lakes) for staging purposes.

Birds will have the potential for collisions during local movement. For example, species that use wetlands (e.g., Waterfowl) are likely to move among wetlands in close proximity to one another, and at relatively low flying heights. Similarly, species that occupy both wetlands and adjacent uplands will move between the two habitat types, and short flight distances will generally be associated with low flying heights.

Research indicates that marking the overhead ground wire (transmission lines) or the conductors (distribution lines) to increase visibility significantly reduces the incidence of avian collisions (APLIC and USFWS 2005). The Avian Protection Plan (APP) Guidelines (APLIC and USFWS 2005) provide a “tool box” of measures from which a utility can select and tailor components, including wire markers, applicable to its specific needs.

Direct and Indirect Mortality

The presence of the ROW and access roads may result in increased public access by OHVs, which in turn can result in changes in recreational activities, particularly hunting levels for waterfowl and upland game species. Depending on the species and the influence of other stressors, hunting pressure may have little effect on Avifauna populations due to reproduction and immigration offsetting hunting mortality, or it could serve as an important source of population decline.

As described in Section 12.2.6 for the Vegetation VEC, access control measures will be developed to monitor and manage public OHV use of the ROW corridor and access roads. The specific measures to be employed will be determined based on the specific geographic conditions of the ROW, and after discussions with regulatory agencies. Measures typically employed for ROW access management include installation of natural barriers and using the natural topography where practicable (e.g., placement of rock barriers, planting of tree and shrub barriers), fencing, and posting of signs prohibiting trespass.

Project activities associated with Operations and Maintenance have the potential to result in spills of fuels and other hazardous or controlled products, and therefore contribute either directly or indirectly to mortality of birds. The potential effects of such accidents are similar to those previously discussed for the Construction phase of the Project, and are particularly relevant for Waterfowl and other birds that spend considerable time on the surface of waterbodies or watercourses. The likelihood and environmental effects of spills will be minimized by following standard mitigation practices for the storage and handling of fuels and other hazardous or controlled products.

Avifauna will be exposed to herbicide applications as part of routine vegetation management within the ROW. Herbicide applications, like other vegetation management initiatives, have varying affects on particular species of avifauna by altering habitat conditions. For example, a study in Oklahoma found that while herbicide-treated sites had higher species richness than untreated areas, the latter were needed to maintain interior woodland species (Schulz et al. 1992). A study in British Columbia found that the nesting success of open-cup nesting species exposed to herbicide applications was significantly lower than controls and that herbicide treatments had more homogeneous communities than did sites which were subject to mechanical vegetation management alone. Other studies, however, suggest that herbicide applications themselves have minimal effects to Avifauna. For example, Marshall and Vandruff (2002) concluded that selective herbicide vegetation management encouraged the development of shrub habitat without negatively affecting the birds nesting in the habitat. Several of the species selected for review by this report have potential to utilize areas within the ROW for nesting purposes, including Common Nighthawk and Short-eared Owl.

The application of herbicide products is a highly regulated activity. Nalcor will meet or exceed the requirements of the application regulations. Therefore, the potential effects of herbicide application on avifauna and other wildlife using the ROW are avoided. All herbicide applications will be approved by the NLDEC pursuant to the Pesticides Control Regulations, 1996 (plus amendments) under the *NLESA.*

Mitigation

Nalcor has standard mitigation measures for transmission Operations and Maintenance throughout the province. Those mitigation measures identified in the Vegetation VEC (Section 12.2.5) that are relevant to vegetation distribution and abundance, wetlands and riparian shoreline would also be effective in limiting effects on Avifauna. Mitigation measures related to vegetation and those directly related to minimizing the effects of the Project on Avifauna represent a continuation of Nalcor's policies and procedures in place during Project Construction, and include:

- Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied when appropriate and will be described in the EPP.
- Upon completion of the Construction phase, temporary access roads will be assessed to determine if they will be needed for Operations and Maintenance; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the trail's condition.
- Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally.
- Ground travel within the ROW for inspection or maintenance of the transmission line will be restricted to existing and / or approved trails. These trails will be used and maintained in accordance with the applicable regulations.
- Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of riparian shoreline(s) will include regular inspection and maintenance of those structures.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.
- Vegetation buffer zones, established at environmentally sensitive areas during Construction, will be maintained. Only danger trees will be removed from these areas.
- Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the

manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002.

- Where possible, annual transmission line maintenance activities within 200 m of an active raptor nest will be scheduled to avoid the sensitive period for that species.
- Only essential vehicular activity, including helicopter flights, will be permitted along the access and transmission line ROW to minimize disturbance to wildlife.
- Transmission line maintenance and repair personnel will not feed or harass wildlife.
- Adjacent to rivers that support breeding Harlequin Duck, operations and maintenance activities will not take place in the vicinity (e.g., 500 m) of breeding pair locations during May 1 to July 31.
- Work within 200 m of an active raptor nest will occur only following discussion with provincial authorities, and may require one or more of the following:
  - only essential vehicular activity, including helicopter flights, and essential machinery and equipment will be permitted along the ROW and access to minimize disturbance to wildlife, including avifauna;
  - work will not be conducted in these areas between June 1 and August 15, unless necessary;
  - where work activity creates a disturbance at the nest site for a period of more than two (2) hours (e.g., adults leave the nest), crews will cease work and move a minimum of 200 m from the nest; work will not resume until activity at the nest has returned to normal for a period of two (2) hours; and
  - crews will not take lunch breaks within 200 m of an active raptor nest.
- Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task, and any inspections, maintenance and / or repairs will be completed as quickly and efficiently as safety allows.
- Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products.
- Well maintained equipment with quality mufflers will be used and equipment maintenance schedules will be followed.
- Engine idling will be minimized and environmental awareness training with key personnel will be conducted on this topic

12.5.6.2 Existing Knowledge

Some of the potential interactions between Operations and Maintenance and Avifauna are similar to Construction (e.g., the effects of noise and disturbance). Others are unique or more prevalent in this phase including use of herbicides, increased OHV access, and risk of collisions and / or electrocution with the transmission lines and towers. Table 12.5.6-1 focuses on the existing knowledge that is relevant to Operations and Maintenance, including mitigation to reduce potential effects.

Table 12.5.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Avifauna

Reference	Study / Project Context	Summary of Findings
Barrett and Weseloh (2008)	Bird Mortality Near High Voltage Transmission Lines in Burlington and Hamilton, Ontario, Canada	– Surveys were conducted between 2000 and 2003 to monitor numbers and species of birds found dead or injured beneath several high voltage transmission lines extending above portions of beaches on western Lake Ontario, Canada. – Surveys at two beach locations indicated annual mortalities of 43 to 211 birds representing 22 species from 2000 to 2003. – Double-crested Cormorant and Ring-billed Gull observed most frequently in these surveys.
Manville (2005)	Bird Strikes And Electrocutions at Power Lines, Communication Towers, and Wind Turbines: State of the Art and State of the Science – Next Steps Toward Mitigation	– Collisions with power transmission and distribution lines estimated to kill from hundreds of thousands to 175 million birds annually, and power lines electrocute tens to hundreds of thousands more annually. Better estimates are unavailable as utilities are poorly monitored for strikes and electrocutions. – Bald Eagle, Red-tailed Hawk and Great Horned Owl are amongst the most commonly reported electrocuted raptors. – Power poles are particularly attractive to raptors where vegetation is low and terrain is flat. – Mitigation varies in cost, depending on whether new construction or retrofitting is required. Sufficient phase-to-phase and phase-to-ground wire spacing is necessary to protect large-winged birds. – Near wetlands, waterbirds, waterfowl, shorebirds, and passerines may be most vulnerable. In habitats away from wetlands, raptors and passerines may be more susceptible. – Marker balls, bird diverters, and paint were shown to reduce collisions.
APLIC and USFWS (2005)	Avian Protection Plan (APP) Guidelines	– APLIC recommends phase-to-phase and phase-to-ground separations based on skin-to skin measurements of Golden Eagle. This avian-safe standard recommends a 60 inch horizontal separation and a 40 inch vertical separation of cables. – Stresses avian-safe design which includes providing appropriate cable separation, and covering cables with appropriate insulation. – Provides various design solutions for various pole configurations and reviews available avian protection products. – Provides guidelines for installing nest platforms. – Stresses the importance of considering habitat, bird use areas, land use, structure design, when siting new lines to avoid collision risks. – Describes the development and necessity of Avian Protection Plans.
Bevanger and Brøseth (2004)	Impact of Power Lines on Bird Mortality in a Subalpine Area	– 4,000 km of power lines in southern Norway were patrolled from 1989 to 1995 to record birds killed from collisions. – 399 birds and 24 species were recorded, but 80% of victims were ptarmigan. – Season, power line section and ptarmigan abundance affected collision rates, with the highest rate in winter (marginally higher than spring). – The annual minimum ptarmigan collision rate was found to be 5.3 birds/km of power line. – Collision spots tended to be in places with low trees.

Table 12.5.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Avifauna (continued)

Reference	Study / Project Context	Summary of Findings
Marshall and Vandruff (2002)	Impact of Selective Herbicide right-of-way Vegetation Treatment on Birds	– Power line ROWs provide important shrub habitat in New York. – Methods used for vegetation management could impact birds of conservation status that are dependent on shrub habitat. – Study looked at plots in two adjacent ROWs before and after a selective herbicide treatment in one of the ROW0s. – Studied Alder Flycatcher, Chestnut-sided Warbler, and Gray Catbird, as all of these exhibit preference for shrub vegetation around nest sites. – Selective herbicide treatment did not significantly decrease shrub vegetation, and neither density nor nesting success declined following treatment. – Concluded that selective herbicide vegetation management encourages the development of shrub habitat without negatively affecting the birds nesting in the habitat.
Thompson et al. (1999)	Avian Communities in forests of Newfoundland, Canada	– Different avian communities occurred in response to changes in vegetation structure and species composition following logging. – Only 42 species of birds were recorded in Newfoundland forests, of which less than half were abundant. – Bird species richness was greater in 40-year old forests. – Grey-cheeked thrush was most abundant in old growth forest.
Whitaker and Montevecchi (1999)	Breeding Bird Assemblages Habiting Riparian Buffer Strips in Newfoundland, Canada	– Avian abundance is usually higher along buffer strips than prior to harvesting due to the attraction of ubiquitous species and species attracted to clear-cut edge habitats. – Varying size buffers tend to attract different guilds of avifauna.
Jacques Whitford (1998)	1997 Osprey Monitoring Program, Environmental Mitigation Program supporting Military Flying Activity in Goose Bay, Labrador	– Osprey nest activity, reproductive success and reproductive output were monitored throughout central Labrador during the 1990s. – Areas examined included the military training area, an adjacent control area, and a series of nests occupying a transmission line between Churchill Falls and Happy Valley-Goose Bay. – Over 168 active and occupied nests, no relationship was detected in relation to military training, but artificial nests on transmission poles exhibited significantly higher nesting success and reproductive output compared to adjacent ‘natural’ nests.

Table 12.5.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Avifauna (continued)

Reference	Study / Project Context	Summary of Findings
Easton and Martin (1998)	The Effect of Vegetation Management on Breeding Bird Communities in British Columbia	– Examined the effect of removing 90–96% of the volume of deciduous trees on breeding bird communities in young conifer plantations during four years. – Trees were removed by two treatments: manual thinning and manual thinning plus application of the herbicide glyphosate. – Herbicide-treated sites remained relatively absent of deciduous vegetation while manually thinned sites had regrowth of deciduous trees. – Turnover of bird species was highest in herbicide-treated areas and lowest in control areas. – Residents, short-distance migrants, ground gleaners, and conifer nesters increased significantly after herbicide treatment. – Deciduous nesters and foliage gleaners increased in abundance (non-significantly) in control and manually thinned areas. – Warbling Vireos declined in areas treated with herbicide. – Nesting success of open-cup nesting species was significantly lower in herbicide-treated than in manually thinned areas. – The composition of bird communities became more homogeneous after herbicide treatment, but showed little change after manual thinning.
Bevanger (1998)	Biological and conservation aspects of bird mortality caused by electricity power lines: a review	– Identifies species with high wing loading and low aspect as having a high risk of colliding with power lines. – Upland game birds (e.g., grouse) are amongst the species of avifauna particularly susceptible to collisions. – Avifauna frequently affected by electrocution include falcons and forest songbirds. – Large numbers of species with legal protective status are among the victims of power lines.
Bramble et al. (1994)	Nesting of Breeding Birds on a Utility Line right-of-way in Pennsylvania, United States	– Active nests of 13 species in a ROW occurred in both hand-cut and herbicide treated segments. – Of the five most common species, nesting success ranged from 67-100% in three maintenance methods that resulted in shrubs, or grass and forb cover remaining at the site. – This nesting success was comparable or higher when compared to forest stands elsewhere.
Schulz et al. 1992	Autumn and Winter Bird Populations in Herbicide Treated Cross-timbers in Oklahoma	– Birds were counted during autumn and winter from 1987 to 1989, 5 and 6 yr after herbicide treatment. – During autumn and winter, more birds and more species were found on-sites treated with herbicides than on reference sites. – Tebuthiuron- and triclopyr-treated sites supported similar numbers of species during both seasons. – Herbicide treated sites had highest species richness, but untreated areas were needed to maintain interior woodland species.

Table 12.5.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Avifauna (continued)

Reference	Study / Project Context	Summary of Findings
Anderson (1978)	Waterfowl collisions with power lines at a coal-fired power plant	– 200 to 400 waterfowl were killed each fall by colliding with high-voltage transmission lines. – Factors found to contribute to the frequency of collisions were: (i) the number of waterfowl present, (ii) weather conditions and visibility, (iii) species composition or behaviour of birds, (iv) disturbance, and (v) familiarity of birds with the area. – Recommended that power lines not be built over water unless alternate routes do not exist, that lines should not cross areas where waterfowl concentrate, and that the visibility of lines in problem areas should be enhanced.

12.5.6.3 Operations and Maintenance Effects: Waterfowl

Operations and Maintenance of the Project is expected to affect Waterfowl through interactions with high voltage transmission lines and electrode lines, mechanical and chemical habitat alteration of the regenerating vegetation on the ROW, and disturbance related to infrastructure maintenance and inspections.

Waterfowl, such as ducks and geese, may be vulnerable to collision casualties because their large, heavy bodies are less manoeuvrable, and because they tend to make high speed feeding runs in the morning and at dusk under low light conditions (Krochko 2005, internet site). A study of Waterfowl interactions with power lines found a number of factors that contribute to the frequency of collisions, including the number of waterfowl present, weather conditions and visibility, species composition or behaviour of birds, disturbance, and familiarity of birds with the area (Anderson 1978). The risk of waterbird mortality is greatest where transmission lines are in close proximity to wetlands and riparian areas that are regularly used for staging or breeding. In particular, data indicate that the majority of bird collisions occur in instances where lines are within 500 m to 800 m of wetland habitat (Brown et al. 1987).

Although collisions between Waterfowl and transmission lines are most likely to occur during local movements, some seasonal trends associated with migration may be expected. Within this context, collisions may be more prominent in regions that are exposed to greater amounts of migratory bird activity. For example, because of its north-south orientation and relative proximity to Labrador at the Strait of Belle Isle, the Northern Peninsula of Newfoundland is an important feature of the Atlantic Flyway (Russell and Fifield 2001). As such, interactions between Waterfowl and transmission lines along the coastal portion of the route may be elevated compared to some other regions and exhibit seasonal patterns due to migratory activity.

Initiatives to reduce collision rates include avoiding areas where Waterfowl concentrate, and enhancing the visibility of lines in problem areas (Anderson 1978). During final routing of the ROW, Nalcor will attempt to minimize the crossing and disturbance of wetland habitat, with particular attention given to large wetland complexes or those that are known to be important for waterfowl.

Waterfowl are considered to be of low risk of electrocution by the transmission lines because they do not generally utilize power poles or other anthropogenic structures for roosting, nesting, courtship, or hunting purposes and because their small size makes it difficult for them to bridge the gap between currents and to therefore become a current-carrying portion of the circuit.

Maintenance of the ROW will involve both mechanical and chemical vegetation control techniques, and these activities will interact with Waterfowl through habitat alteration and sensory disturbance, depending on the season. The herbicide Tordon 101 (with Sylgard 309 as a surfactant) will be applied by qualified, trained personnel in a careful manner, following the manufacturers' instructions and the requirements of the applicable regulations will be met or exceeded. Such activities will be performed periodically according to the maintenance schedule, but may also occur intermittently as a result of unforeseen maintenance requirements and / or inspections. Whereas such activities may adversely influence a number of Waterfowl, interactions with Harlequin Ducks are considered to be most important as a result of their high fidelity to breeding areas and general sensitivity. Breeding pairs such as those found on the Castor River are particularly sensitive and have low success rates. As such, Project maintenance activities within the vicinity (e.g., 500 m) of locations where breeding Harlequin Duck have been reported (e.g., Trimper et al. 2008; Thomas 2008) will not take place from May through July to limit disturbance to this species. The herbicide (i.e., Tordon 101 with Sylgard 309 as a surfactant) that Nalcor is proposing to use is non-toxic to wild birds.

Waterfowl are likely to be exposed to increased hunting pressure as a result of the presence of Project infrastructure, which provides a means of improved OHV and snowmobile access for hunters. Waterfowl species such as Surf Scoter and Harlequin Duck are particularly vulnerable to hunting pressures because many are not capable of flight at the start of the hunting season in early September (LGL Limited 2008). Although Harlequin Duck are not legally hunted in the province of Newfoundland and Labrador, juveniles and females are easily confused with other species of Waterfowl and some individuals may be shot occasionally. Insufficient hunter education is the key component contributing to the misidentification, and subsequent mortality of Harlequin Duck during hunting activities (Environment Canada 2007a).

The Project ROW and associated access roads have the potential to play a role in the sensory disturbance of Harlequin Ducks on breeding rivers by providing increased access for other recreational purposes. For example, large scale rafting is known to be disruptive to Harlequin Ducks (Hunt 1998), and recreational fishers may present a problem when they remain along watercourses for long periods of time (Wallen 1987). As previously discussed, a variety of mitigation measures will be employed to limit unwanted traffic along the ROW, including the possible use of barriers and other access control measures.

Accidents and malfunctions could occur during Operations and Maintenance, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, multiple tower failure, localized slope failure) on Waterfowl may result in alteration or loss of habitat types. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited in scale, the proposed mitigation is likely to minimize the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants which will be addressed quickly and is not likely to have a measurable effect on Waterfowl.

Summary of Likely Residual Environmental Effects

The likely residual effects of Operations and Maintenance on Waterfowl are as follows:

- Adverse, because they include interactions with high voltage transmission lines and electrode lines, mechanical and chemical habitat alteration within the ROW, increased access and associated hunting pressure, and sensory disturbance;
- Of low magnitude, because of the low number of Waterfowl within the RSA that are likely to interact with the transmission lines via collisions or electrocutions, be influenced by increased hunting pressures, or be exposed to habitat alteration and / or sensory disturbance during maintenance activities;
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are likely to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA; and
- Of far future duration because the Operations and Maintenance phase will continue throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extensive baseline information, detailed habitat mapping and understanding of habitat association of the various species and a good understanding of the species' responses to Project interactions. In addition, the conservative assessment approach using the 20% contingency (i.e., precautionary approach), and Nalcor's commitment to applying the mitigation measures add confidence to the prediction.

12.5.6.4 Operations and Maintenance Effects: Passerines

Operations and Maintenance of the Project is expected to affect Passerines through interactions with high voltage transmission lines and electrode lines, vegetation management, infrastructure maintenance and repairs.

As with other Avifauna, there is the potential for passerines to be adversely affected by the presence of transmission lines through collisions. However, the small size and agility of most passerines limits the potential for collisions with transmission lines because they are able to react quickly to the presence of unexpected obstacles (Bevanger 1998). Nonetheless, there is the potential for collision rates to exhibit seasonal patterns, particularly along features where migratory activity is concentrated, such as the Northern Peninsula of Newfoundland. For example, collisions with man-made structures are known to cause mortalities of the Grey-cheeked Thrush during its migration (Lowther et al. 2001, internet site), although the effect of such features in Newfoundland and Labrador is not known (NLDEC-W 2010).

Maintenance of the ROW corridor will be performed using both mechanical and chemical vegetation control activities, and these will interact with Passerines through habitat alteration and sensory disturbance. The herbicide Tordon 101 (with Sylgard 309 as a surfactant) will be applied by qualified, trained personnel in a careful manner, following the manufacturers' instructions and the requirements of the applicable regulations will be met or exceeded. This herbicide is non-toxic to wildlife. The effects of vegetation management on Passerines will vary depending on the species and may provide benefits to some. For example, periodic maintenance within the ROW will promote an early successional vegetation community and the presence of forest edge along the ROW boundary. Many Passerine species, such as the Olive-sided Flycatcher, utilize edges and may therefore benefit from increased habitat availability. Other species, such as the Red Crossbill, use interior forest habitats, and are unlikely to benefit from management of the ROW vegetation.

The small size of passerines makes it difficult for them to bridge the gap between currents of electrical systems, and therefore, the potential for them being electrocuted by the transmission lines is low. Additionally, Passerines are not generally hunted and as a result, increased OHV and / or snowmobile access are not predicted to adversely affect this KI.

Summary of Likely Residual Environmental Effects

The likely residual effects of Operations and Maintenance on Passerines are as follows:

- Adverse, because they include interactions with high voltage transmission lines and electrode lines, sensory disturbance, and mechanical and chemical habitat alteration, although the effects of the latter will vary depending on the species of interest;
- Of low magnitude, because of the low number of Passerines within the RSA that are likely to interact with transmission lines via collisions or electrocutions, be influenced by increased access and associated hunting pressure, or be exposed to habitat alterations and / or sensory disturbance during maintenance activities;
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are likely to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA; and
- Of far future because the Operations and Maintenance phase will continue throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat associations, Project information, the understanding of interactions, a conservative assessment approach using the 20% contingency, the nature of the mitigation measures and resulting environmental effects.

12.5.6.5 Operations and Maintenance Effects: Raptors

Operations and Maintenance of the Project is expected to affect Raptors through interactions with Project infrastructure, vegetation management and infrastructure maintenance.

Raptors are opportunistic and may use utility structures for a number of purposes, such as nest sites, high points from which to defend territories, and perches from which to hunt (APLIC and USFWS 2005). Such structures can benefit raptors, particularly by providing perching and / or nesting opportunities in areas where few natural perches or nest sites exist. Some utility structures are preferred by birds because they provide considerable elevation above the surrounding terrain, thereby offering a wide field of view. "Still hunting" from a perch is energy efficient for a bird, provided that good prey habitat is within view (APLIC and USFWS 2005). However, utility structures also pose a threat to Raptors and other birds through electrocutions or collisions.

Raptors are the most common victims of electrocutions because of their natural attraction to power poles for roosting, nesting, courtship and hunting, with eagles being the most commonly reported electrocuted bird (Manville 2005). However, unlike distribution lines, which serve to deliver local energy requirements and have energized parts that are close together, transmission line systems cause few electrocutions because their lines are not usually close enough to allow birds to bridge the gap between currents and unwittingly become a current-carrying portion of the circuit (Platt 2002). As previously discussed, the clearance between the optical overhead groundwire and the energized conductors on the proposed transmission towers for the Project (approximately 8 m) is greater than the maximum wing span of raptors within the Study Area (maximum wingspans for Bald Eagle are approximately 2.5 m). However, there is some potential for the electrocution of raptors along the low voltage electrode lines, particularly when they are being used to provide a return path for the full current. Additionally, because these lines will be in close proximity to coastal features, there will be elevated risks of their use by Osprey and Bald Eagle.

Being relatively large, heavy-bodied, and less agile than many other bird groups, Raptors are generally susceptible to collisions with power lines. Collisions with high-tension guy wires have been documented as a source of accidental mortality for the Short-eared Owl (Cadman and Page 1994). Because of their attraction to aquatic habitats for feeding purposes, the potential for Bald Eagle and Osprey collisions with power lines may be elevated where the Project crosses, or is in close proximity to, waterbodies and wetlands. However, raptors are also well-documented to interact with power lines away from such features and are considered amongst the most susceptible bird groups to collisions in upland habitats (Erickson et al. 2005).

Maintenance activities or increased OHV and / or snowmobile traffic within the ROW have potential to result in sensory disturbance to Raptors as discussed for Construction. Although moderately tolerant of human activity throughout much of their range (Vana-Miller 1987), Osprey nesting in areas away from humans may be adversely affected by disturbance such that it can result in lower reproductive success (Van Daele and Van Daele 1982). Sensory disturbance from human activity can have an adverse effect if it prompts adults to flush from the nest sufficiently often or long enough to jeopardize the survival of eggs or young. As such, disturbances associated with maintenance activities have the potential to be most damaging during incubation and early nestling (Trimper et al. 1998a; Levenson and Koplin 1984).

Similarly, Bald Eagle are sensitive to human disturbances throughout their nesting period, being most likely to abandon nests during the courtship and nest building phases (USFWS 2010, internet site). Because Short-eared Owl nests on the ground they are potentially sensitive to changes in predation activities and human recreational activities (Schmelzer 2005) that may result from increased access along the ROW. With respect to human activities, repeated disturbance associated with OHVs and other recreational uses, or transmission line maintenance equipment during nesting or brood rearing may result in nest abandonment and or failure (Schmelzer 2005). To minimize sensory disturbance to raptors, annual transmission line maintenance activities within 200 m of an active raptor nest will only be conducted in consultation with the NLDEC, and may require specific conditions. Additionally, as previously discussed, access control measures will be developed during Construction and maintained during Operations and Maintenance to reduce sensory disturbances associated with recreational activity within the ROW.

Vegetation management activities within the ROW may provide some indirect benefits to raptors through increased feeding opportunities. For example, Short-eared Owl prefer open habitats for feeding (Warkentin and Newton 2009) and may therefore benefit from the conversion of heavily-forested habitats to early succession vegetation communities that are promoted by maintenance activities. However, due to their wide distribution, high trophic status and territoriality, raptors have the potential to accumulate environmental contaminants (Sheffield 1997). For example, they are considered susceptible to secondary poisoning from rodenticides and pesticides through consumption of contaminated prey items (Steininger 1952). However, the application of herbicide products is a highly regulated activity. The herbicide Tordon 101 (with Sylgard 309 as a surfactant) will be applied by qualified, trained personnel in a careful manner, following the manufacturers' instructions and the requirements of the applicable regulations will be met or exceeded. All herbicide applications will be approved by the NLDEC pursuant to the Pesticides Control Regulations, 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002.

Summary of Likely Residual Environmental Effects

The likely residual effects of Operations and Maintenance on Raptors are predicted to be as follows:

- Adverse, because they include interactions with high voltage transmission lines and electrode lines, sensory disturbance, and mechanical and chemical habitat alteration;
- Of low magnitude, because of the low number of Raptors within the RSA that are likely to interact with transmission lines via collisions or electrocutions, or be exposed to habitat alteration, sensory disturbance, or other potential sources of indirect mortality during maintenance activities;
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are likely to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA; and
- Of far future duration because the Operations and Maintenance phase will continue throughout the life of the Project. There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association, Project information, the understanding of interactions, a conservative assessment approach using the 20% contingency, the nature of the mitigation measures and resulting environmental effects.

12.5.6.6 Operations and Maintenance Effects: Upland Game Birds

Operations and Maintenance of the Project is expected to affect Upland Game Bird species through interactions with high voltage transmission lines and electrode lines, increased access and associated hunting pressure, vegetation management and infrastructure maintenance.

Upland Game Bird species appear to be relatively susceptible to collisions with power lines. For example, a study in Norway found that 80% of victims of collisions were ptarmigan (Bevanger and Brøseth 2004). This study also found that collision rates were influenced by the season, section of the powerline, and ptarmigan abundance, with incidences being highest in the winter and spring. Maintenance of the ROW may also result in some inadvertent collisions between vehicles and upland game species. However, despite their potential to be relatively susceptible, only minimal amounts of upland game populations are likely to be involved in collisions with lines or vehicles during Project Operations and Maintenance.

Species of Upland Game Birds are likely to be exposed to increased hunting pressure as a result of Project infrastructure providing a means of improved OHV and snowmobile access for hunters. Although increased hunting pressure as a result of changes in road access has been found to result in as much as five to 29% of Ruffed Grouse mortality, most studies have concluded that hunting has a negligible effect on the population viability of this species (Rusch et al. 2000). Furthermore, the degree of increased hunting pressure within the majority of the LSA is likely to be low as a result of its remoteness and the low human population densities found in nearby communities. Additionally, a variety of mitigation measures will be employed to limit unwanted recreational use of the ROW, as previously discussed.

Summary of Likely Residual Environmental Effects

The likely residual effects of Operations and Maintenance on Upland Game Bird species are as follows:

- Adverse, because they include interactions with high voltage transmission lines, sensory disturbance, mechanical and chemical habitat alteration, and increased hunting pressure from increased access;
- Of low magnitude, because of the low number of Upland Game Birds within the RSA that are expected to interact with transmission lines via collisions or electrocutions, be influenced by increased hunting pressures or be exposed to habitat alteration and / or sensory disturbance during maintenance activities;
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are expected to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA; and
- Of far future duration because the Operations and Maintenance phase will continue throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association, Project information, the understanding of interactions, a conservative assessment approach using the 20% contingency, the nature of the mitigation measures and resulting environmental effects.

12.5.6.7 Operations and Maintenance Effects: Other Species of Special Conservation Status

Operations and Maintenance of the Project is expected to affect Other Species of Special Conservation Status through interactions with high voltage transmission lines and electrode lines, vegetation management and infrastructure maintenance, but effects are expected to be minimal.

Although activities associated with Operations and Maintenance may disturb Common Nighthawk, this relatively uncommon species uses a variety of open habitats, including cutovers, and may therefore find some increased habitat opportunities as a result of periodic vegetation management. However, collisions with motor vehicles have been reported as a mortality factor for several Common Nighthawk populations in North America, and populations that use dirt roads in managed forests as roost or nest sites are known to be affected by increased vehicle traffic (including ATVs), which collide with adults or destroy nests (J. Gauthier 2005, pers. comm. cited in Savignac 2007; Poulin et al. 1996, internet site; Bender and Brigham 1995). Nighthawks may also collide with aircraft and relatively high mortality rates have been reported during fall migration at some sites (Cumming et al. 2003). However, the frequency and intensity of any increased vehicle use as a result of the Project is unlikely to increase levels of mortality for this species.

Red Knot congregate in large groups in traditional staging areas during migration and this potential makes them more vulnerable to disturbance, pollution, and loss of resources than other species of shorebirds (COSEWIC 2007b, internet site). However, as discussed previously, the migratory stopover locations for this species are located outside of the LSA and interaction between Red Knot and Project Operations and Maintenance is unlikely. According to local bird experts, there are few, if any, threats to this species that would cause a significant decrease in their numbers within the province (Garland and Thomas 2009).

Summary of Likely Residual Environmental Effects

The likely residual effects of Operations and Maintenance on Other Species of Special Conservation Status are as follows:

- Adverse, because they include interactions with high voltage transmission lines and electrode lines, sensory disturbance, and mechanical and chemical habitat alteration;
- Of low magnitude, because of the low number of Other Species of Special Conservation Status within the RSA that are likely to interact with transmission lines via collisions or electrocutions, be influenced by increased access and associated hunting pressure or be exposed to habitat alteration and / or sensory disturbance during maintenance activities;
- Limited to the RSA, as physical disturbance of habitat will be limited to the LSA, but habitat changes are likely to overlap with home ranges that extend into the RSA, and noise and associated disturbance will likely extend into the RSA; and
- Of far future duration, because the Operations and Maintenance phase will continue throughout the life of the Project.

There is a high degree of confidence that the level of effect will not be greater than predicted. This confidence is based on the extent of baseline information, detailed habitat mapping and understanding of habitat association, Project information, the understanding of interactions, a conservative assessment approach using the 20% contingency, the nature of the mitigation measures and resulting environmental effects.

12.5.7 Environmental Effects Summary and Evaluation of Significance

12.5.7.1 Summary of Likely Environmental Effects

Avifauna populations will be influenced in a variety of ways by Construction and Operations and Maintenance. The primary effect of Construction activities on bird populations will be through habitat alteration and loss. Secondary effects include temporary sensory disturbance and the potential for other indirect and direct sources of mortality through vehicle collisions and spills of fuels or other hazardous or controlled products. Operations and Maintenance is likely to adversely affect avifauna primarily through their interactions with high voltage transmission lines and electrode lines, increased access and associated hunting pressure, and sensory and habitat disturbances through maintenance activities such as inspection, repairs and vegetation management. The Project will have varied affects on Avifauna, as represented by effects to the diversity of species considered in this assessment.

A summary of Project effects on Avifauna KIs for Construction, and Operations and Maintenance is provided in Table 12.5.7-1.

Table 12.5.7-1 Environmental Effects Analysis Summary: Avifauna

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Waterfowl	**Adverse** – Effects will include a decrease in habitat, temporary sensory disturbances and other sources of direct and indirect Avifauna mortality.	**Low** – 1% or less of the wetland waterfowl habitat available in the RSA is predicted to be intersected by the ROW, by region. As a result, the Project is predicted to have a negligible effect on regional Waterfowl populations. To be precautionary, mitigation regarding ROW alignment is not considered in this calculation.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance is expected to extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Habitat loss through vegetation clearing will occur once and will result in an overall change to habitat within the ROW. – Sensory disturbance will occur regularly while construction crews are active in a particular area.
Passerines	**Adverse** – Effects will include a decrease in habitat, temporary sensory disturbances and other sources of direct and indirect Avifauna mortality.	**Low** – <1% of the primary habitat available for passerines in the RSA is predicted to be intersected by the ROW. As a result, the Project is predicted to have a negligible effect on regional Passerine populations.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance is likely to extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Habitat loss through vegetation clearing will occur once and will result in an overall change to habitat within the ROW. – Sensory disturbance will occur regularly while construction crews are active in a particular area.

Table 12.5.7-1 Environmental Effects Analysis Summary: Avifauna (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Raptors	**Adverse** – Effects will include a decrease in habitat, temporary sensory disturbances and other sources of direct and indirect Avifauna mortality.	**Low** – <1% of the primary habitat available for Raptors in the RSA is predicted to be intersected by the ROW. The combined effects of habitat loss or alteration, sensory disturbance and sources of mortality during the most sensitive periods (i.e., breeding, nesting and rearing) are predicted to have a negligible effect on regional Raptor populations.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance is expected to extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Habitat loss through vegetation clearing will occur once and will result in an overall change to habitat within the ROW. – Sensory disturbance will occur regularly while construction crews are active in a particular area.
Upland Game Birds	**Adverse** – Effects will include a decrease in habitat, temporary sensory disturbances and other sources of direct and indirect Avifauna mortality.	**Low** – Little of the available primary habitat is likely to be altered (no primary habitat for Ruffed Grouse) within the RSA. The combined effects of habitat loss or alteration, sensory disturbance and sources of mortality during the most sensitive periods (i.e., breeding, nesting and rearing) are predicted to have a neglibible effect on regional Upland Game Bird populations.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance is expected to extend throughout Construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Habitat loss through vegetation clearing will occur once and will result in an overall change to habitat within the ROW. – Sensory disturbance will occur regularly while construction crews are active in a particular area.

Table 12.5.7-1 Environmental Effects Analysis Summary: Avifauna (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Other Species of Special Conservation Status	**Adverse** – Effects will include a decrease in habitat, temporary sensory disturbances and other sources of direct and indirect avifauna mortality.	**Low** – <1% of the primary habitat available for common nighthawk in the RSA is predicted to be intersected by the ROW, which will not interact with known migratory stopover locations for Red Knot. The combined effects of habitat loss or alteration, sensory disturbance and sources of mortality during the most sensitive periods (i.e., breeding, nesting and rearing) are predicted to have a negligible effect on regional populations of Other Species of Special Conservation Status.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Medium-term to Far Future** – Sensory disturbance is expected to extend throughout construction. – Effects to habitat within the access and ROW and overlapping home ranges will persist for the life of the Project.	– Habitat loss through vegetation clearing will occur once and will result in an overall change to habitat within the ROW. – Sensory disturbance will occur regularly while construction crews are active in a particular area.

Summary of Likely Residual Construction Effects on Avifauna:

he amount of Avifauna habitat altered or lost to ROW and other Project components during Construction is likely to have minimal effects on Avifauna populations at the regional level, considering specific mitigation and vegetation regeneration within the ROW. Disturbance associated with Construction activities may displace individual animals for the short to medium-term, depending on the activity type, but the regional distribution of Avifauna is not likely to be affected. Any increase in hunting or other land use pressure is not likely to affect species composition, distribution patterns, or densities of Avifauna in the LSA or RSA.

Table 12.5.7-1 Environmental Effects Analysis Summary: Avifauna (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Operations and Maintenance					
Waterfowl	**Adverse** – Effects will include interactions with high voltage transmission lines, increased hunting pressure, mechanical and chemical habitat alteration, and sensory disturbance.	**Low** – Low number within the RSA are likely to interact with Project infrastructure, maintenance activities, or other human activities that may result from increased access opportunities.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	**Periodic and Intermittent** – Effect likely expressed periodically in conjunction with maintenance schedule and season (e.g., migration) as well as intermittently as a result of enhanced access, and / or wildlife behaviour.
Passerines	**Adverse** – Effects will include interactions with high voltage transmission lines, mechanical and chemical habitat alteration and sensory disturbance.	**Low** – Low number within the RSA are likely to interact with Project infrastructure, maintenance activities, or other human activities that may result from increased access opportunities.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	**Periodic and Intermittent** – Effect likely expressed periodically in conjunction with maintenance schedule and season (e.g., migration) as well as intermittently as a result of enhanced access, and / or wildlife behaviour.

Table 12.5.7-1 Environmental Effects Analysis Summary: Avifauna (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Raptors	**Adverse** – Effects will include interactions with high voltage transmission lines, mechanical and chemical habitat alteration and sensory disturbance.	**Low** – Low number within the RSA are likely to interact with Project infrastructure, maintenance activities, or other human activities that may result from increased access opportunities.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	**Periodic and Intermittent** – Effect likely expressed periodically in conjunction with maintenance schedule and season (e.g., migration) as well as intermittently as a result of enhanced access, and / or wildlife behaviour.
Upland Game Birds	**Adverse** – Effects will include interactions with high voltage transmission lines, mechanical and chemical habitat alteration, increased hunting pressure, and sensory disturbance.	**Low** – Low number within the RSA are likley to interact with Project infrastructure, maintenance activities, or other human activities that may result from increased access opportunities.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	**Periodic and Intermittent** – Effect likely expressed periodically in conjunction with maintenance schedule and season (e.g., migration) as well as intermittently as a result of enhanced access, and / or wildlife behaviour.
Other Species of Special Conservation Status	**Adverse** – Effects will include interactions with high voltage transmission lines, mechanical and chemical habitat alteration, increased hunting pressure, and sensory disturbance.	**Low** – Low number within the RSA are likely to interact with Project infrastructure, maintenance activities, or other human activities that may result from increased access opportunities.	**Local to Regional** – Effects to habitat will be limited to the LSA; disturbance effects will likely extend into the RSA.	**Far Future** – Effects will be evident throughout the life of the Project.	**Periodic and Intermittent** – Effect likely expressed periodically in conjunction with maintenance schedule and season (e.g., migration) as well as intermittently as a result of enhanced access, and / or wildlife behaviour.
Summary of Likely Residual Operations and Maintenance Effects on Avifauna: Based on the nature of the proposed Project, and with the incorporation of standard mitigation, the likelihood of interactions with Avifauna during Operations and Maintenance is low, and limited to short-term disturbances to localized portions of the ROW and individual animals in the vicinity. Operations and Maintenance of the Project is not likely to have a measurable effect on the species composition, distribution patterns, or densities of Avifauna in the LSA or RSA.					

12.5.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level.

Maintaining sustainable Avifauna populations will allow for the continued ecological and societal role of avifauna into the future. A significant adverse residual environmental effect of the Project on Avifauna is one that would cause a change in the population or regional distribution of a species such that its population is not sustainable. An environmental effect that does not meet these criteria is not significant.

Likely residual effects of the Project on Avifauna are expected to be adverse and may extend into the far future. For all the Avifauna KIs, however, the Project is likely to result in the direct loss or alteration of generally 1% or less of available habitat in the RSA. Considering this and the planned mitigation measures to limit vegetation clearing, allow vegetation regeneration, and the low likelihood of Project-Avifauna interactions, the residual effect will not be of sufficient magnitude to comprise the sustainability of populations within the RSA.

The Project is not likely to adversely affect the sustainability of populations of any of the Avifauna KIs or representative species / guilds therein. Therefore, the Project is not likely to result in significant adverse environmental effects on Avifauna.

12.5.8 Evaluation of Project Alternatives

As the transmission corridor must connect all facilities, the evaluation of alternatives considered corridors that were feasible from technical and environmental perspectives, between Muskrat Falls in Central and Southeastern Labrador and Soldiers Pond on the Avalon Peninsula. Routing, used as a mitigation strategy, was used to limit the environmental footprint (e.g., utilize existing disturbance corridors to the extent practical, avoid environmentally sensitive areas such as Gros Morne National Park), while considering engineering and construction requirements. This routing process incorporated information collected during the consultation. Ten alternative transmission corridor segments have been identified by Nalcor, including two in Central and Southeastern Labrador, five on the Northern Peninsula, two in Central and Eastern Newfoundland, and one on the Avalon Peninsula.

The various alternative segments considered in this assessment could vary in their respective effects on the selected KIs in relation to alteration or loss of primary and secondary habitat for select species. As such, the character of the alternative corridors and the proposed alignment were compared using information on the habitat types preferred by each of the species for which habitat mapping was completed (Table 12.5.8-1). This comparison has been conducted at the level of the LSA (i.e., the 2 km wide corridor) rather than the hypothetical centre line ROW because the precise routing of the ROW within the transmission corridor is not known at this time. Additional notes on the known presence of species of special conservation status, as indicated by ACCDC records (ACCDC 2010, internet site; ACCDC 2008, internet site), are included in the relevant alternative descriptions, as applicable. While these comparisons are useful in providing a general indication of relative effects on the KIs, they do not represent the actual amount of habitat potentially disturbed or lost as this will depend on the final alignment of the ROW, with the applicable mitigation applied.

Table 12.5.8-1 Summary Evaluation of Project Alternative Means: Avifauna

Project Alternative Means[a]	Environmental Implications (Compared to the Proposed Transmission Corridor)[b]
	Waterfowl, Upland Game Birds, Raptors, Passerines, and Species of Special Conservation Status
A2: Northwest of Strait of Belle Isle Alternative Segment	This alternative corridor segment has 1.0 km^2 more habitat than the proposed corridor segment. This includes 3 km^2 more of Conifer Scrub and 2 km^2 more of Lichen Heathland. It will traverse 3 km^2 less Wetland Habitat. The implications of this alternative would be greater effects on such species as Grey-cheeked Thrush and Blackpoll Warbler, and less effects on wetland affiliated species such as Canada Goose, Rusty Blackbird and Wetland Sparrows.
A3: Point Amour Alternative Segment	The alternative corridor segment has approximately 18 km^2 less habitat than the proposed corridor segment, including 18 km^2 less Conifer Scrub, <1 km^2 less Wetland, and 2 km^2 more Lichen Heathland. The lower amount of Conifer Scrub potentially affected by this alternative would result in less effects on Grey-cheeked Thrush and Blackpoll Warbler.
A4: Strait of Belle Isle Newfoundland Side Alternative Segment	The alternative corridor segment has 13 km^2 more habitat than the proposed corridor segment. This includes 9 km^2 more of Open Conifer Forest and 3 km^2 more of Scrub / Heathland / Wetland Complex. This alternative corridor segment has greater implications for Blackpoll Warbler and Common Nighthawk in association with the Open Conifer Forest, and Rusty Blackbird, Blackpoll Warbler, and Wetland Sparrows due to the greater amount of Scrub / Heathland / Wetland Complex affected.
A5: GNP Northeast Alternative Segment	The alternative corridor segment has more habitat than the proposed corridor segment. This includes 5 km^2 more of Open Conifer Forest (that provides primary habitat for Blackpoll Warbler and Common Nighthawk) and 2.4 km^2 more of Scrub / Heathland / Wetland Complex that provides primary habitat for Rusty Blackbird, Blackpoll Warbler, and Wetland Sparrows. The alternative corridor segment, however, does traverse 2 km^2 less of Wetland Habitat than the proposed corridor. Whereas both the proposed corridor and alternative cross Castor River West, the alternative corridor segment does so further upstream and within portions of the river which are known to support breeding pairs of Harlequin Duck (Stassinu Stantec Limited Partnership 2010; ACCDC 2008, internet site).
A6: GNP West-central Alternative Segment	The alternative corridor segment has less habitat than the proposed corridor segment. This includes 9 km^2 less of Conifer Forest, 1 km^2 less of Conifer Scrub, 7 km^2 less of Open Conifer Forest and 5 km^2 less of Scrub / Heathland / Wetland Complex. The alternative corridor segment would have less effect on coniferous habitat affiliated species such as Grey-cheeked Thrush, Blackpoll Warbler, and Common Nighthawk. The alternative corridor segment traverses 15 km^2 less of Mixedwood Forest which is rated as primary habitat for Grey-cheeked Thrush.
A7: GNP Eastern LRM Crossing Alternative Segment	The alternative corridor segment has less habitat than the proposed corridor segment. This includes 1.4 km^2 less Mixedwood Forest, 3 km^2 less Open Conifer Forest, 7 km^2 less Scrub / Heathland / Wetland Complex and 5 km^2 less Wetland Habitat. It traverses 13 km^2 more of Conifer Forest, and 2 km^2 more of Conifer Scrub used by Grey-cheeked Thrush and Blackpoll Warbler. Harlequin Duck have been observed along the portion of Brian's Pond Brook that is crossed by the proposed corridor segment (ACCDC 2008, internet site), and the A7 alternative corridor segment crosses both Brian's Pond Brook and Inner Pond Brook in locations where Harlequin Duck have been recorded (Stassinu Stantec Limited Partnership 2010; ACCDC 2008, internet site).

Table 12.5.8-1 Summary Evaluation of Project Alternative Means: Avifauna (continued)

Project Alternative Means[(a)]	Environmental Implications (Compared to the Proposed Transmission Corridor)[(b)]
	Waterfowl, Upland Game Birds, Raptors, Passerines, and Species of Special Conservation Status
A7: GNP Eastern LRM Crossing Alternative Segment + A8: GNP IATNL Alternative Segment	The alternative corridor segment has more habitat than the proposed corridor segment. This includes 16 km^2 more of Conifer Forest, 2 km^2 more of Conifer Scrub, and 5 km^2 more of Open Conifer Forest used by Grey-cheeked Thrush, Blackpoll Warbler and Common Nighthawk. In addition, there will be 5 km^2 more Wetland Habitat that supports species such as Canada Goose, Rusty Blackbird, Blackpoll Warbler, and Wetland Sparrows.
A9: Birchy Lake Alternative Segment	The alternative corridor segment has 13 km^2 more habitat than the proposed corridor segment. This includes a variety of less affected habitats such as 2 km^2 more Cutover, 4 km^2 more Mixedwood Forest, 1 km^2 more Open Conifer Forest, 3 km^2 more Scrub / Heathland / Wetland Complex and 3 km^2 more Wetland Habitat which would result in increased effects on a wide variety of avian species.
A10: NLOA Alternative Segment	This alternative corridor segment occurs almost entirely beyond the RSA, and therefore insufficient information exists for a detailed habitat comparison. However, the proposed corridor segment is 87 km in length, while the alternative corridor segment is 130 km. This represents an increase of approximately 43 km in length which would be expected to result in greater effects on many species of avifauna. Rusty Blackbird have been recorded approximately mid-way along the A10 alternative corridor.
A11: Avalon Alternative Segment	The alternative corridor segment has 3 km^2 less habitat than the proposed corridor segment. With the exception of Cutover (2 km^2) and Mixedwood Forest (1 km^2), the difference in the amount of habitat between the proposed corridor segment and the alternative corridor segment were all less than 1 km^2 and therefore of little consequence for the various avifauna species of interest.

— Indicates that avifauna distribution does not overlap with this alternative.

(a) As identified and described in Chapter 2, Project Rationale and Planning.

(b) Namely, the proposed Project described in the EIS Project Description Chapter 3, and assessed in the preceding Environmental Effects Analysis.

Because of the variety of habitat types present along the proposed and alternative corridors and differences in their habitat use for the suite of avifauna species included in this VEC, it is challenging to provide a concise, yet thorough, evaluation of the likely relative effects of the proposed corridor in comparison to the alternatives. However, given the importance of Wetland Habitat and Scrub / Heathland / Wetland Complex Habitat for several of the selected species (i.e., Canada Goose, Rusty Blackbird, Blackpoll Warbler, Wetland Sparrows and Short-eared Owl), alternatives which have a greater potential to affect these habitat types also have a greater potential effect on avifauna in general. The proposed corridor traverses a similar amount of habitat or less habitat than the alternatives, and is likely to have similar or lesser effects on Wetland and Scrub / Heathland / Wetland Complex habitats. Alternatives A3, A6, A7, and A11 are shorter than the proposed corridor, however, and most of these (i.e., A3, A6, A7) also traverse through less wetland. The overall habitat traversed by the A7+A8 alternative corridors is more, but it crosses less wetland habitat.

Data on the distribution of species of special conservation status along the alternative corridors indicates that several of the alternatives are in conflict with federally and / or provincially designated Species at Risk. In particular, alternatives A5 and A7 are in conflict with areas where Harlequin Duck have been reported, and are known to breed. Whereas both the A5 alternate and the corresponding section of the proposed corridor cross Castor River West, which is known to harbour breeding Harlequin Duck, the A5 alternate does so further upstream and within portions of the river that are known to support breeding pairs. Similarly, whereas this species has been observed along the portion of Brian's Pond Brook, which is crossed by the proposed corridor, the A7 alternate crosses both Brian's Pond Brook and Inner Pond Brook in locations where Harlequin Duck has been recorded (Stassinu Stantec Limited Partnership 2010a; ACCDC 2008, internet site). Additionally, data indicate that the Rusty Blackbird has been recorded approximately midway along the A10 alternate corridor near Buchans during both 2003 and 2006 (ACCDC 2010, internet site), suggesting that the alternative corridor could interact with this species.

12.5.9 Cumulative Environmental Effects

Cumulative environmental effects are those likely residual environmental effects of the Project that overlap in time and space within the RSA with likely environmental effects from other projects and activities. The environmental effects of past and existing projects and activities are captured in the baseline conditions for Avifauna (i.e., as presented in the existing environment chapter). Currently, much of the landscape within the RSA is relatively intact, although areas with considerable amounts of infrastructure (e.g., road networks) and / or subject to disturbance activities (e.g., forestry) are present, particularly in Central and Eastern Newfoundland and on the Avalon Peninsula.

Much of the Labrador portion of the RSA remains relatively undisturbed by anthropogenic activity and populations therein are considered to be in a "natural" state. However, the north-western portion of the RSA follows the TLH3 and is within the Low Level Training Area (LLTA) military area and would therefore be subject to fragmentation and infrequent sensory disturbance effects. While some behavioural reactions to aircraft have been noted, no effects on reproduction or survival at the individual or population level have been documented (LaPierre 2008, pers. comm.). A study on the effects of low-level flying military aircraft on Harlequin Ducks in Labrador observed behavioural responses, but there was insufficient data to determine any population level effect on the species (Goudie and Jones 2004). Physiological investigations of the response of moulting Black Duck (Minaskuat Limited Partnership 2005c), and behavioural reactions of nesting Osprey (Trimper et al. 1998a, b; Minaskuat Limited Partnership 2003a), nesting Canada Jay (Minaskuat Limited Partnership 2003b) and nesting Canada Geese (Minaskuat Limited Partnership 2007, 2004) to military and civilian over-flights demonstrated short-term (i.e., usually <5 minute) reactions with no measurable effect on reproductive success or at a population level. Additionally, communities and associated infrastructure are present at the northern (i.e., Muskrat Falls) and southern (i.e., Strait of Belle Isle) segments of the RSA, and avifauna within these areas are likely to have been affected by associated activities, including habitat loss, fragmentation, and hunting pressure.

Avifauna habitats and populations within the Newfoundland segment of the RSA have been subjected to greater degrees of anthropogenic effects, as evidenced by the presence of human development, access roads, various aged cut blocks and intensity of recreational activity. However, much of the non-commercial forest landscape crossed by the Project is still in a relatively "natural" state, including large tracts of land on the Northern Peninsula. Stressors to Avifauna in Newfoundland that the Project has the potential to interact with include a diversity of infrastructure, such as that associated with transportation (e.g., the TCH, secondary and tertiary roads, woods roads), commercial (e.g., existing transmission lines) and residential activities, as well as disturbance processes, particularly those related to forest management. Due to the migratory nature of many Avifauna species, stressors acting within the RSA are not necessarily indicative of effects to Avifauna populations.

The primary environmental effect of Project Construction on Avifauna within the RSA will be through an alteration or loss of habitat. However, a number of other Project components or activities also have potential to affect Avifauna, including vegetation management initiatives, the presence of high voltage transmission lines, sensory disturbance, and subsequent increased OHV use and hunting pressure. Nalcor has committed to mitigation measures that will limit Project effects on Avifauna habitat and populations. Overall, residual environmental effects to Avifauna are low to moderate in magnitude, are limited to the RSA and, with mitigation in place, have been determined to be not significant.

Future activities that result in the clearing or disturbance of vegetation have the greatest potential to act cumulatively with the Project to affect Avifauna. These clearing activities may create additional sources of sensory disturbance, including during sensitive times of the year, and may increase access for OHVs, resulting in disturbance to potentially sensitive habitats / nesting areas and / or result in increased hunting pressure. The reasonably foreseeable future projects considered in the cumulative effects assessment for the Labrador portion of the Project include:

- Lower Churchill Hydroelectric Generation Project;
- TLH3 (although recently completed, operational effects may not be reflected in the current baseline);
- 5 Wing Goose Bay Military Flight Training;
- commercial forestry activity (FMDs 19A and 21);
- general economic and infrastructure development in the Central Labrador and Labrador Straits Region; and
- other land uses activities, particularly OHV use.

For Newfoundland, the reasonably foreseeable projects and activities considered in the cumulative effects assessment include:

- general economic and infrastructure development;
- commercial forestry activity (FMDs 1, 2, 4, 6, 9, 10, 11, 12, 16, 17, and 18);
- Parsons Pond oil and gas exploration drilling; and
- other land use activities, particularly OHV use.

Locally situated projects such as the Parsons Pond oil and gas exploration project are not likely to act cumulatively because the geographic scope of these activities is limited and / or may occur within previously disturbed areas. However, there is potential for cumulative effects to occur as a result of interactions between the Project and the effects associated with the Lower Churchill Hydroelectric Generation Project. For example, Rusty Blackbird populations have been considered sensitive to mercury contamination of boreal wetlands following forestry activities and the creation of hydroelectric reservoirs (Gerrard and St. Louis 2001; Garcia and Carignan 2000; DesGranges et al. 1998). Additionally, future forestry activities and recreational pressure may act cumulatively with the effects of the Project.

Commercial forestry activity in general involves wide-scale vegetation clearing, which could result in habitat fragmentation, loss of nests and nesting sites, damage to wetlands and riparian zones and increased public OHV access through logging roads. In particular, forestry activities have contributed to population declines of provincially and / or federally designated species at risk that are known to occur within the RSA. For example, forestry operations continue to expand into known breeding areas of Harlequin Duck within Atlantic Canada, and logging activities are known to remove suitable breeding habitat and also increase stream siltation that may affect food availability (Crowley and Patten 1996; Breault and Savard 1991). However, as noted in the management plan for Harlequin Duck (Environment Canada 2007a), it is difficult to fully assess the impact of forestry across its range because the majority of breeding for the regional population occurs in Labrador (Trimper et al. 2008), which is not presently exploited by the forest industry. Forestry activity in the province is conducted through District-based Sustainable Forest Management Plans, and includes Five Year Operating Plans that detail the specific mitigation and management measures to minimize the potential environmental effects of these activities. This, in conjunction with forestry exhibiting a general decline on the Island of Newfoundland due to the closure of several mills in recent years, will limit the potential for cumulative effects of forestry with the Project.

Project activities and infrastructure may interact with existing stressors in the RSA resulting in cumulative effects on Avifauna. For example, as a result of clearings and roads created by the Project and other developments, cumulative sensory disturbances and hunting effects may occur as a result of increased public OHV access. To limit the contribution to cumulative environmental effects resulting from recreational activities, access control measures will be developed to monitor and manage public OHV and other uses of the Project ROW, roads and trails. This will include an education component, local community involvement with active participation and support from Nalcor, and ongoing evaluation during inspections.

The effects of the Project in combination with other projects and activities that have been or will be carried out are not expected to result in an effect on the Avifauna KIs that would cause a change in the population or regional distribution of a species such that its population will not be sustainable. Therefore, significant cumulative effects on the Avifauna VEC are not likely to occur. The planning, consultative and other effects management measures identified for this VEC will serve to avoid or reduce potential interactions and adverse effects as a result of the Project. Avoiding or managing potential effects on Vegetation resulting from other ongoing and future projects and activities will require that appropriate resource management, planning, regulatory and enforcement measures are in place and implemented by the relevant agencies.

A description and determination of the likely cumulative environmental effects of the Project in each geographic region are provided in Table 12.5.9-1. With an ongoing and adaptive management plan in place for the Project, cumulative environmental effects are rated as not significant. For the specifics of the effects (e.g., amount of habitat altered or lost) the reader is referred to Table 12.5.7-1.

Note, all other projects or activities listed in Table 9.3.9-2, are not considered in the cumulative effects assessment on Avifauna as these developments do not overlap spatially with the Project and are not in proximity to the RSA, and therefore no cumulative effects are likely.

Additional mitigation is not considered to be necessary to eliminate or reduce the predicted cumulative effects on Avifauna.

Table 12.5.9-1 Cumulative Environmental Effects Summary: Avifauna

Cumulative Environmental Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Current (Baseline) VEC Condition (reflecting the effects of past and ongoing projects and activities)	Avian populations, including listed species, are considered stable. They are influenced by limited human activities in the region and may be considered to be in a relatively “natural” state (not considering the influence of stressors acting in other parts of their range). Existing projects and activities that have and continue to affect Avifauna populations by habitat alteration or loss include the TLH3, and the northern (Muskrat Falls) and southern (Strait of Belle Isle communities and infrastructure) segments, and activities associated with the LLTA military area within the north-western section of the RSA.	Avian populations, including listed species, are considered stable. They are and have been influenced by extensive forest harvesting and recreational activities in the region. Nevertheless, these populations may be considered to be in a relatively “natural” state (not considering the influence of stressors acting in other parts of their range). Existing projects and activities that have and continue to affect Avifauna populations through habitat alteration or loss include the various developments (e.g., roads, transmission lines, communities) and timber harvesting.	Avian populations, including listed species, are considered stable. They are influenced by low to moderate amounts of human activities in the region. Existing projects and activities that have and continue to affect avifauna populations through habitat alteration or loss include various developments (e.g., roads, transmission lines, communities) and timber harvesting.	A concentration of human development (e.g., roads, transmission lines, villages, cottages) occurs within the RSA primarily due to the proximity of population centres. As such, Avian populations may be considered stable but they are moderately influenced through habitat alteration or loss by human activities in region.
Likely Residual Environmental Effects of Labrador - Island Transmission Link	Residual environmental effects include habitat alteration or loss and fragmentation, sensory disturbance, incidental take (via electrocutions and collisions with transmission lines and vehicles), and ncreased access and associated hunting pressure.	Residual environmental effects include habitat alteration or loss and fragmentation, sensory disturbance, incidental take (via electrocutions and collisions with transmission lines and vehicles), and increased access and associated hunting pressure.	Residual environmental effects include habitat alteration or loss and fragmentation, sensory disturbance, incidental take (via electrocutions and collisions with transmission lines and vehicles), and increased access and associated hunting pressure.	Residual environmental effects include habitat alteration or loss and fragmentation, sensory disturbance, incidental take (via electrocutions and collisions with transmission lines and vehicles), and increased access and associated hunting pressure.

Table 12.5.9-1 Cumulative Environmental Effects Summary: Avifauna (continued)

Cumulative Environmental Effects Analysis	Central and Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	Overlapping projects and activities that will affect habitat alteration or loss in particular include: the Lower Churchill Hydroelectric Generation Project, TLH3, commercial forestry activity (FMDs 19 and 21), general economic and Infrastructure development in the Central Labrador and Labrador Straits region, and other land uses, particularly OHV use.	Overlapping projects that will affect habitat alteration or loss in particular include general economic and Infrastructure development, commercial forestry activity, Parsons Pond oil and gas exploration drilling, and other land uses, particularly OHV use.	Overlapping projects that will affect habitat alteration or loss in particular include general economic and infrastructure development, commercial forestry activity, and other land uses, particularly OHV use.	Overlapping projects that will affect habitat alteration or loss in particular include general economic and Infrastructure development, commercial forestry activity, and other land uses, particularly OHV use.
Cumulative Environmental Effects Summary	**Not Significant** While the contribution of the Project to cumulative environmental effects will extend through the life of the Project, effects such as habitat alteration or loss will be limited in scale to the LSA or potentially the RSA (relative to OHV access along the transmission ROW and access trails), and low in magnitude. The cumulative effects are not expected to cause a change in the population or regional distribution of a species such that its population is not sustainable.	**Not Significant** While the contribution of the Project to cumulative environmental effects will extend through the life of the Project, effects such as habitat alteration or loss will be limited in scale to the LSA or potentially RSA (relative to OHV access along the transmission ROW and access trails), and low in magnitude. The cumulative effects are not expected to cause a change in the population or regional distribution of a species such that its population is not sustainable.	**Not Significant** While the contribution of the Project to cumulative environmental effects will extend through the life of the Project, effects such as habitat alteration or loss will be limited in scale to the LSA or potentially RSA (relative to OHV access along the transmission ROW and access trails), and low in magnitude. The cumulative effects are not expected to cause a change in the population or regional distribution of a species such that its population is not sustainable.	**Not Significant** While the contribution of the Project to cumulative environmental effects will extend through the life of the Project, effects such as habitat alteration or loss will be limited in scale to the LSA or potentially RSA (relative to OHV access along the transmission ROW and access trails), and low in magnitude. The cumulative effects are not expected to cause a change in the population or regional distribution of a species such that its population is not sustainable.

12.5.10 Monitoring and Follow-up

A follow-up study will be undertaken by Nalcor to evaluate the presence of breeding pairs of Harlequin Duck on rivers known to support this species (Trimper et al. 2008; Thomas 2008) that are affected by the Project. Within Labrador, the Project will cross two rivers on which breeding pairs have been recorded infrequently, Traverspine River and St. Paul River. Harlequin Duck was first observed along the Traverspine in 2010 (Stassinu Stantec Limited Partnership 2010). A pair of Harlequin Duck was observed along the St. Paul River in 1998 (AGRA Earth and Environmental Ltd. and Harlequin Enterprises 1999), but this area is not known to have been surveyed for this species since that time (Trimper et al. 2008). Nalcor will survey relevant portions of these rivers (i.e., 5 km upstream and downstream) during the appropriate season before Construction activities commence to determine the extent of breeding activities. The findings of these surveys will be used to refine and optimize proposed mitigation. All proposed mitigation will be refined and optimized during monitoring and follow-up.

In Newfoundland, Nalcor will implement the same procedures at rivers known to support breeding Harlequin Duck pairs, particularly on the Northern Peninsula (e.g., Torrent River) and possibly in south-eastern Newfoundland on the Bay du Nord River (Thomas 2008; IBA 2012). This information will be used by Nalcor for consideration in the identification of final alignment across these rivers in consultation with the Canadian Wildlife Service.

Additionally, Nalcor will conduct Harlequin Duck surveys along rivers crossed by the Project that are known to support breeding populations. This program will be initiated immediately following the Construction phase of the Project and continue for a period of two years following commencement of Operations and Maintenance. These follow-up surveys will document the abundance and distribution of Harlequin Duck along the watercourses in the areas crossed by the Project to determine the effects of the Project on breeding pairs.

While there are no known important areas for Red Knot in the province, they may occur in small numbers in the Study Area. Nalcor will note any observations of this or other species of conservation status.

Osprey and Bald Eagle nests will be identified within the LSA through aerial surveys for nesting activity prior to Project Construction. In the unlikely event that nests have to be relocated as a result of vegetation clearing activities, nesting success will be determined in early June and in mid-August prior to fledging for the season following construction.

The ROW and other Project components (e.g., access) will be routinely inspected by Nalcor throughout the life of the Project. During these inspections, which will be conducted either from the ground or the air, the inspectors will maintain a log of observations or evidence of Avifauna involved with vehicle collisions or interactions with the transmission line (i.e., collisions or electrocutions), and note any areas of environmental concern related to Avifauna within or adjacent to the Project components. These observations will include the presence of nests on transmission towers or poles, and unauthorized access and resulting disturbance. As part of the access control measures, Nalcor will also note public OHV use of transmission corridor roads and trails observed during maintenance and inspections.

12.6 Environmental Assessment Summary

This section presents a summary of the EA for the Terrestrial Environment. Subsections address the following:

- effects management measures planned for the Project to address identified issues;
- species of Special Conservation Concern and their assessment;
- likely effects of moderate to high risk accidents and malfunctions and planned mitigation and response measures;
- predicted likely residual Project effects and their significance;
- likely cumulative environmental effects associated with the Project; and
- environmental monitoring and follow-up programs planned in relation to the Project.

12.6.1 Effects Management Measures

Table 12.6.1-1 and Table 12.6.1-2 provide a summary of the effects management measures that Nalcor has incorporated into the Project for Construction, and Operations and Maintenance, respectively. Nalcor has designed the terrestrial Project components specifically to address identified issues, and is proposing to use best management practices and mitigation options designed to avoid or reduce the effects of the Project on the Terrestrial Environment. Further, through their adaptive management process, Nalcor will assess issues that arise during the Construction, and Operations and Maintenance phases to allow appropriate changes to be made to mitigation strategies or methods, and adopted in a timely manner.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment

VEC / KI	Proposed Mitigation
Vegetation Abundance and Diversity	– Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands, riparian shorelines, listed plant habitats), difficult to reclaim, or of stakeholder or management concern (i.e., uncommon Habitat Types, limestone barrens). – Existing access roads will be used and development of new access will be minimized, to the extent practical. – Vegetation clearing activities will comply with the requirements of all applicable permits. – Clearing activities will only occur within the ROW and other site specific areas (e.g., converter station, marshalling yards, camps). – Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures: ▪ All vegetation shall be cut within 150 mm of the surface of the ground ▪ All vegetation that exceeds 2 m height at maturity will be cut ▪ Trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed ▪ All vegetation will be selectively cleared (mechanical-felling, hand-felling and piling) from the ROW to secure the transmission line ▪ Merchantable timber will be clerared through various means (e.g., feller-buncher (mechanical), hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m – Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats. – A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage. – No cutting will occur within 100 m of the centre line of a public highway without approval from the NLDNR. – Trails will be cleared to the width of the vehicles that will use them (usually 4 m), as safety allows. – Cleared timber will be used in the construction of corduroy bridges (i.e., logs or timber laid parallel to each other as a temporary and low impact crossing structure), where appropriate, to cross areas of saturated soils and wetland areas. – Grubbing will not be permitted within 2 m of standing timber. – During grubbing activities, site-appropriate erosion prevention and sediment control measures will be implemented, and could include (but not be limited to) surface water diversion ditches, silt fences, stone or brush cover, erosion control fabrics, settling ponds and other sediment filtration and flow management products.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– Grubbing will not be conducted in saturated conditions, during or immediately following a precipitation event. Where appropriate, grubbed materials will be re-spread or stockpiled and as many stumps and roots as possible will be left on the ground surface to maintain soil cohesion, to dissipate energy from run-off and promote natural revegetation. – The length of time that grubbed areas are left exposed to natural elements will be limited to prevent unnecessary surface run-off and erosion. – Erosion control measures including brush cover, stone riprap, wire mesh, settling ponds and drainage channels will be implemented in areas prone to soil loss. – Topsoil stripping within or near areas with existing non-native or invasive species populations will be managed, where practical, to reduce the potential spread of these species. – Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species. – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust. – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* – Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel. – Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response. – Construction staging areas will be located and operated in a manner that limits disturbance to native vegetation to the extent practical. Unless otherwise agreed upon with the NLDEC, all construction materials and debris will be removed from marshalling yards and construction staging areas when Construction is complete, and the areas returned to original land use capability, regraded and allowed to revegetate naturally.
Vegetation – Wetlands	– Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands), and the minimum practical footprint will be used for construction activities. – All Nalcor mitigation measures referencing setbacks and buffers for waterbodies will also be applied to wetlands, as appropriate. – If construction is required in wetland areas, Nalcor will conduct the work in winter, fall, late summer, summer, spring (in order of preference), to the extent practical. – Only construction equipment necessary to install the tower assembly within wetlands will be operated in or transported through wetlands; all other equipment will use an alternate route. – Construction site drainage features, such as ditches, will be designed such that wetland hydrology is maintained, to the extent possible. Discharge of storm water, wastewater, or diversion of surface water during construction will be directed away from wetlands, where practical, unless it is intended to maintain pre-construction hydrology.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– There will be no discharge of silt-laden, contaminated or nutrient-enriched water (e.g., sewage) to wetlands. – The upper organic layer of organic material will be salvaged and stored for restoration purposes where construction is required within a wetland (e.g., if an access has to cross a wetland). – Silt fences will be installed on all approaches to wetlands, as appropriate, to prevent erosion and sedimentation. – To limit the potential for adverse effects from hazardous or regulated materials, use of the least toxic products will be a priority when working in and around wetlands. – Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel. – Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response. – Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water. – Refuelling and maintaining of equipment and machinery will not be permitted within 50 m of a waterbody, wetland or flood-prone area. – Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species. – Natural recovery will be used for wetlands in areas that are healthy and have few non-native or invasive plant species. – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.
Vegetation – Riparian Shoreline	– Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands, riparian shorelines, listed plant habitats), difficult to reclaim, or of stakeholder or management concern (i.e., uncommon Habitat Types, limestone barrens). – Existing trails, roads or cut-lines will be used to the extent practical to avoid disturbance to riparian vegetation and, where practical, access roads and trails will be located to avoid riparian shoreline. – At watercourse crossings, the width of the cleared ROW will be reduced to 3 m for a minimum 15 m distance away from the shoreline. Where practical, the reduced ROW width will apply for the entire buffer zone if greater than 15 m. This could include selective cutting in these areas. – Trails will be cleared to the width of the vehicles that will use them (usually 4 m), as safety allows. – Trees, logs, slash, brush or debris will not be deposited in (or on, if frozen) any waterbody or disposed of within 30 m of the high water mark of any waterbody. – Buffer zones (non-disturbance areas) of various widths around watercourses and waterbodies will be implemented as follows: ▪ Approval will be obtained from the Government of Newfoundland and Labrador for development activities to take place within riparian areas in a designated PPWSA (Section 48 *Water Resources Act* 2002 (GNL 2002, internet site)); activities that could aggravate flooding or result in

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	unmitigated adverse water quality effects will not be permitted. Development and approval will be obtained for activities to take place within a prescribed distance from the edge of a watercourse or waterbody, as follows: – Intake lake or pond (150 m) – River intake (150 m (applied 1 km upstream and 100 m downstream)) – Major river channel (75 m) – Major tributaries, lakes or ponds (50 m) – Other waterbodies (30 m) ▪ In non-PPWSAs, the minimum buffer zone width will be determined using the formula: 12 m + 1.5 m x slope of the land (percent) or 20 m, whichever is larger ▪ To protect scheduled salmon rivers, a minimum 30 m buffer will remain from the high water mark (DFO 2009, internet site) – Camp plans will be reviewed prior to the commencement of construction so that buffer zones are flagged prior to any disturbance activities. – Approaches to fording sites will be stabilized (e.g., by use of swamp mats, corduroy), as appropriate, to avoid rutting. – Bridges will be placed entirely above the high water mark and will not be located on meander bends, braided streams, alluvial fans, active flood plains, or any other inherently unstable area, and will be installed perpendicular to the watercourse. – Where practical, removal of riparian vegetation will occur by hand. If machinery is required, it will be operated in a manner that minimizes disturbance to the banks of the waterbody and banks will be restored to their original or stable condition. – Erosions control measures including brush cover, stone riprap, geotextile, settling ponds and drainage channels will be implemented in areas prone to soil loss. The length of time grubbed or otherwise disturbed areas are left exposed to natural elements will be limited to prevent unnecessary erosion. – Blasting operations near a watercourse will be conducted in accordance with the *Guidelines for Protection of Freshwater Fish Habitat in Newfoundland and Labrador* (Gosse et al. 1998). – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust. – Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water. – Refuelling and maintaining of equipment and machinery will not be permitted within 50 m of a waterbody, wetland or flood-prone area. – Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species. – Mineral soils exposed as a result of surface disturbance within riparian areas will be vegetated with native plants (using vegetated topsoil salvaged from areas of alteration), and covered with mulch to prevent soil erosion and encourage seed germination. If there is insufficient growing season remaining, the site will be stabilized and vegetated the following spring.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
Vegetation – Listed Plants or Regionally Uncommon Plants	– Project components and the final ROW alignment will be sited and routed to avoid, to the extent practical, vegetation communities that are identified as sensitive to disturbance (e.g., wetlands, riparian shorelines, listed plant habitats), difficult to reclaim, or of stakeholder or management concern (i.e., uncommon Habitat Types, limestone barrens) – Nalcor has committed to re-run the Regionally Uncommon Plant model once a ROW has been selected, based on input and advice from the NLDEC Wildlife Division – Nalcor will adhere to federal and provincial guidelines or management plans relating to listed or regionally uncommon plants (e.g., NL Species at Risk Policy, COSEWIC Status Reports, *SARA* Recovery Strategies), unless otherwise approved by appropriate regulatory agencies Nalcor will consult with NLDEC Wildlife Division regarding siting, routing or mitigation strategies for Project infrastructure in the vicinity of known listed plants or species of con*cern*, particularly within the Northern Peninsula where a diversity of such species exists. Using information compiled by the NLDEC and LBHSP, the Project route and component sites will be selected to avoid known occurrences of individual species and their preferred habitat to the extent practical. – Where avoidance is not possible, Nalcor, in consultation with federal and provincial regulators, will develop protection measures and environmental management techniques for listed or regionally uncommon plant species based on site-specific conditions and species sensitivity criteria. – Qualified personnel will undertake pre-construction plant surveys of High or Very High rated habitat (for regionally uncommon species) and important habitat (for listed plants) crossed by Project components, to identify any occurrences. Species and site-specific mitigation measures will be developed as required. The following is a list of mitigation options that could be used: ▪ Align the ROW around or narrow the ROW in known locations of listed or regionally uncommon plants or their habitats to partially or completely avoid the habitat, to the extent practical ▪ Flag known locations of listed or regionally uncommon plant species within the Project components prior to construction and avoided to the extent practical. Where avoidance is not practical, other mitigation measures will be developed (e.g., transplanting) in consultation with the appropriate regulatory authorities ▪ To protect known listed or regionally uncommon plant sites that occur within Project ROWs or workspaces, clearing of vegetation in these areas will be conducted by hand and the area of disturbance will be minimized (e.g., stripping of trenchline only through limestone barrens) ▪ Retain a qualified botanist to assist in the development and implementation of an appropriate mitigation strategy if any individual listed or regionally uncommon plant species is located during construction ▪ Delay construction timing within environmentally sensitive areas (i.e., limestone barrens), to the extent practical. Creation of a snow or ice cap (or other acceptable materials) to protect known listed plant sites within the ROW will be considered ▪ If appropriate for the species, seeds will be harvested or transplant material collected for reclamation of specific listed plants – Nalcor will inspect equipment required for Construction before use to reduce the potential for the introduction of non-native and invasive plant species. – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* – Vegetation buffer zones will be established at environmentally sensitive areas during Construction – Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– All spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel. – Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response. – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust.
Vegetation - Timber Resources	– Nalcor will comply with existing provincial legislation and regulation (Newfoundland and Labrador *Forestry Act* 1990). – Merchantable timber within areas supporting Project components will be cleared in accordance with provincial guidelines. – Trails will be cleared to the width of the vehicles that will use them (usually 4 m), as safety allows – Where practical and feasible, timber cleared, but not intended for commercial use, will be made available for domestic use. – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* – Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction. – All spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel. – Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response.
Caribou	– Nalcor will use the data on caribou core areas provided by the NLDEC Wildlife Division during final ROW alignment selection to avoid Primary Core area, to the extent feasible. – New access roads will, to the extent practical, be routed to avoid Primary Core area of Newfoundland caribou by at least 500 m. – Vegetation removal will be limited to reduce opportunities for direct and indirect mortality of caribou such as: ▪ Clearing activities will only occur within the ROW and other site specific areas (e.g., converter station, marshalling yards, camps) – Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures: ▪ All vegetation shall be cut within 150 mm of the surface of the ground ▪ All vegetation that exceeds 2 m height at maturity will be cut ▪ Trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed ▪ Merchantable timber will be cleared through various means (e.g., feller-buncher (mechanical),

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m – Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats. – A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* – Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction. – All spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel. – Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response. – Clearing activities will only occur within the ROW and other site specific areas. – Existing access roads will be used and development of new access will be minimized, to the extent practical. – Nalcor will comply with laws and regulations pertaining to fish and wildlife, forest fires, forest travel, smoking and littering. – Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic. – Well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust. – Haul distances for construction material will be limited to the extent practical. – Construction activities will be conducted in accordance with municipal by-laws regarding noise. – High noise-producing construction equipment will be strategically placed as far away as practical from receptors. – All equipment will have appropriate mufflers and will be well maintained. – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP – The size of explosive charges will be limited during blasting activities. Three hours prior to any blasting, a visual reconnaissance of the area will be conducted to establish the presence of any wildlife; blasting will be delayed where practical until wildlife have been allowed to leave the area of their own accord. – Work activities will occur in a manner that does not deliberately harass wildlife. – Only essential vehicular activity, including helicopter flights, will be permitted within the transmission ROW to minimize disturbance to wildlife.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– Project personnel will adhere to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions. – Signage will be installed to indicate crossing areas in known caribou crossing areas. – Active work areas and access roads will be off limits to unescorted non-Project personnel, including during hunting season. – During the sensitive calving and post-calving season, Nalcor will limit activity in Primary Core area of Newfoundland caribou, as feasible. – Site-specific mitigation measures relating to caribou will be developed as practical prior to and during Project Construction in consultation with NLDEC. – Project personnel will not be permitted to possess firearms or have pets on-site and Nalcor will enforce a 'no-harvesting' policy during working hours. The exception to firearm possession will be bear monitors as described in the EPP. – Nalcor will continue to participate on the LWCRT and support related research, such as the telemetry monitoring program.
Furbearers	– Nalcor will consult with the NLDEC Wildlife Division regarding final routing of the ROW in the vicinity of known marten habitat, particularly within the Northern Peninsula. – Nalcor will use detailed imagery to route the ROW to minimize the amount of primary and secondary habitat traversed, and identify areas where other mitigation options (e.g., restricting the width of the ROW or leaving slash piles within the ROW to provide security areas for marten) would be implemented. – Nalcor will use existing disturbed areas and corridors as much as possible, limit the number of access roads, and decommission roads not required for Operations and Maintenance. – Existing access roads will be used and development of new access will be minimized, to the extent practical. – Clearing activities will only occur within the ROW and other site specific areas (e.g., converter station, marshalling yards, camps). – Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures: ▪ All vegetation shall be cut within 150 mm of the surface of the ground ▪ All vegetation that exceeds 2 m height at maturity will be cut ▪ Trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed ▪ Merchantable timber will be cleared through various means (e.g., feller-buncher (mechanical), hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m – Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats. – A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.*

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel. – Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response. – All spills will be reported to the designated Environmental Monitor, construction supervisor, or designated Project personnel. – Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic. – Well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust. – Haul distances for construction material will be limited to the extent practical. – Construction activities will be conducted in accordance with municipal by-laws regarding noise. – High noise-producing construction equipment will be strategically placed as far away as practical from receptors. – All equipment will have appropriate mufflers and will be well maintained. – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP. – The size of explosive charges will be limited during blasting activities. – Construction staging areas will be located and operated in a manner that limits disturbance to native vegetation to the extent practical. – Unless otherwise agreed upon with the NLDEC, all construction materials and debris will be removed from marshalling yards and construction staging areas when Construction is complete, and the areas returned to original land use capability, regraded and allowed to revegetate naturally. – Nalcor will comply with laws and regulations pertaining to fish and wildlife, forest fires, forest travel, smoking and littering. – Hardwood vegetation within 30 m of waterbodies occupied by beaver will not be cleared, unless clearing is required for electrical line clearance. – Culverts will be removed from water crossings of access roads not required for Operations and Maintenance so as not to attract beaver. – Three hours prior to any blasting, a visual reconnaissance of the area will be undertaken to determine the presence of any wildlife; blasting will be delayed where practical until wildlife have been allowed to leave the area. – Work areas will be kept clean and organized at all times; crews will collect and dispose of all waste away from the job site, as appropriate. – Project personnel will take all necessary precautions to prevent and minimize any spillage, misplacement or loss of fuels and other hazardous materials. – Work activities will occur in a manner that does not deliberately harass wildlife.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– Only essential vehicle use, including helicopter flights, will be permitted within the transmission corridor to limit disturbance to wildlife. – Project personnel will adhere to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions. – Project personnel will not be permitted to possess firearms or have pets on-site and Nalcor will enforce a 'no-harvesting' policy during working hours. The exception to firearm possession will be bear monitors as described in the EPP. – Site-specific mitigation measures relating to furbearers will be developed prior to and during Project Construction if necessary.
Avifauna	– An avifauna management plan will be designed and implemented (Environment Canada 2007a) to address all vegetation clearing and reduce the possibility of inadvertent destruction of the nests and eggs of migratory birds, and will be included in the EPP. – Final ROW alignment and access routing will consider the location of known high concentrations of waterfowl to the extent possible. – The final ROW alignment will avoid known breeding sites where feasible. – Existing trails, roads or cut-lines will be used and development of new access will be minimized, to the extent practical, to avoid disturbance to riparian vegetation and, where practical, access roads and trails will be located to avoid riparian shoreline. – A pre-Construction survey will be conducted to identify the location of Bald Eagle and Osprey (or other raptor species if detected) nests. – Nest searches will be conducted prior to clearing if clearing activities are conducted during the breeding season of other (non-raptor) migratory birds, and a 30 m buffer around active nests will be maintained during construction activities to demonstrate due diligence in terms of the *Migratory Birds Convention Act.* – Clearing activities will only occur within the ROW and other site specific areas (i.e., converter station, marshalling yards, camps). – Clearing will not be conducted within 800 m of an active raptor nest during the nesting period (May 15 to July 31) unless clearing is delayed until the nest is no longer occupied; and, clearing will not be conducted within 200 m of an active raptor nest during the non-nesting season. – Where nests must be cleared, mitigation involving placement of artificial nests will be implemented, if appropriate, in consultation with the NLDEC Wildlife Division. – At watercourse crossings, the width of the cleared ROW will be reduced to 3 m for a minimum 15 m distance away from the shoreline. Where practical, the reduced ROW width will apply for the entire buffer zone if greater than 15 m. This could include selective cutting in these areas. – A vegetated buffer extending 30 m from the water's edge will be maintained for the transmission line ROW to protect known waterfowl staging areas.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– Buffer zones (non-disturbance areas) of various widths around watercourses and waterbodies will be implemented as follows: ▪ Approval will be obtained from the Government of Newfoundland and Labrador for development activities to take place within riparian areas in a designated PPWSA (Section 48 *Water Resources Act* 2002 (GNL 2002, internet site)); activities that could aggravate flooding or result in unmitigated adverse water quality effects will not be permitted. Development and approval will be obtained for activities to take place within a prescribed distance from the edge of a watercourse or waterbody, as follows: Waterbody — Minimum Buffer Width Intake lake or pond — 150 m River intake — 150 m (applied 1 km upstream and 100 m downstream) Major river channel — 75 m Major tributaries, lakes or ponds — 50 m Other Waterbodies — 30 m ▪ In non-PPWSA, the minimum buffer zone width will be determined using the formula: 12 m + 1.5 m x slope of the land (percent) or 20 m, whichever is larger. ▪ To protect scheduled salmon rivers, a minimum 30 m buffer will remain from the high water mark (DFO 2009, internet site). – Vegetation clearing for the transmission ROW and other Project components will be conducted using the following measures: ▪ All vegetation shall be cut within 150 mm of the surface of the ground ▪ All vegetation that exceeds 2 m height at maturity will be cut ▪ Trees will be felled onto the ROW away from standing forest and away from any waterbody; any leaning or danger trees partially knocked down during clearing will be removed ▪ Merchantable timber will be cleared through various means (e.g., feller-buncher (mechanical), hand-falling), de-limbed, and neatly piled at a right angle to, but within the ROW, to a height not exceeding 3 m – Tree tops, limbs, brush and debris will be piled along the edge of the ROW or used for brush mats. – A 6.5 m break will remain between slash piles at least every 200 m to facilitate drainage and wildlife passage. – Stockpiled salvaged timber, slash, brush and debris will be removed within 6 m of each side of the ROW centre line. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Refuelling and maintaining of equipment and machinery will not be permitted within 50 m of a waterbody, wetland or flood-prone area. – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* – Spill kits will be available at all work sites, and a spill response team will be formed and trained prior to Construction, and all spills will be reported to the designated Environmental Monitor, Construction Supervisor, or designated Project personnel.

Table 12.6.1-1 Construction Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC / KI	Proposed Mitigation
	– Any spill of reportable quantities of hazardous or regulated materials will be contained immediately and the application of absorbent pads (e.g., granular, pillow, sock) will be used to absorb and contain the spill; these spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response. – Engine idling will be minimized and environmental awareness training with key contract personnel will be conducted on this topic. – Well maintained equipment with quality mufflers will be used, and equipment maintenance schedules will be followed. – During windy conditions, specific Project activities that generate air-borne dust will be assessed on a case by case basis and corrective actions implemented as warranted and appropriate to reduce dust. – Haul distances for construction material will be limited to the extent practical. – Construction activities will be conducted in accordance with municipal by-laws regarding noises. – High noise-producing construction equipment will be strategically placed as far away as practical from receptors. – Blasting activities will be designed and undertaken in compliance with provincial and federal regulations. – Blasting mats will be used in environmentally sensitive areas as defined in the EPP. – The size of explosive charges will be limited during blasting activities. – Construction staging areas will be located and operated in a manner that limits disturbance to native vegetation to the extent practical. – Unless otherwise agreed upon with the NLDEC, all construction materials and debris will be removed from marshalling yards and construction staging areas when Construction is complete, and the areas returned to original land use capability, regraded and allowed to revegetate naturally. – Permanent or temporary camps will not be established within 800 m of an active raptor nest. – No work will be conducted within 200 m of an active raptor nest unless in consultation with the NLDEC Wildlife Division. – Construction activities will not take place from May 1 to July 31 within the immediate vicinity of locations where breeding pairs of Harlequin Ducks have been recorded to minimize the potential for sensory disturbance. – Work activities will be conducted in a manner that does not deliberately harass wildlife, including avifauna. – Only essential vehicular activity, including helicopter flights, will be permitted along the transmission line route to minimize disturbance to wildlife, including avifauna. – Project personnel will not be permitted to possess firearms or have pets on-site and Nalcor will enforce a 'no-harvesting' policy during working hours. The exception to firearm possession will be bear monitors as described in the EPP.

Table 12.6.1-2 Operations and Maintenance Mitigation Strategies and Methods – Terrestrial Environment

VEC	Proposed Mitigation
Vegetation	– Ground travel within the ROW for inspection or maintenance of the transmission line will be restricted to existing and / or approved trails. These trails will be used and maintained in accordance with the applicable regulations. – Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of riparian shoreline(s) will include regular inspection and maintenance of those structures. – Nalcor will not use sterilants as a means of vegetation control, but will rely on non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. This approach will avoid the potential for soil sterility issues. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002. – All herbicide application will be performed by applicators certified with an "Industrial Vegetation" license issued by the NLDEC. Herbicide application will not be undertaken in PPWSAs, private or provincial parks, ecological reserves, or on private lands without permission of the owner. – Personnel conducting vegetation control will be made aware of the known locations of listed species and their habitat. Herbicide will not be used within 30 m of these sites; maps and GPS coordinates of locations will be provided. – Upon completion of the Construction phase, temporary access will be assessed to determine if it will be needed for Operations and Maintenance; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the road or trail condition. – Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally. – Nalcor will inspect equipment required for Operations and Maintenance before use to reduce the potential for the introduction of non-native and invasive plant species. – Vegetation buffer zones, established at environmentally sensitive areas during construction, will be maintained. Only danger trees will be removed from these areas. – The vegetation maintenance technique will allow the root system to remain intact, allowing the soil to bind and encourage rapid colonization of low-growing plant species. – Erosion control measures installed during or after Construction will be inspected and maintained as part of Operations and Maintenance activities. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products. – Refuelling and maintaining of equipment and machinery will not be permitted within 50 m of a waterbody, wetland or flood-prone area. – Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied as applicable and will be described in the EPP.
Caribou	– Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of riparian shoreline(s) will include regular inspection and maintenance of those structures. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

Table 12.6.1-2 Operations and Maintenance Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC	Proposed Mitigation
	– Vegetation buffer zones, established at environmentally sensitive areas during Construction, will be maintained. Only danger trees will be removed from these areas. – Upon completion of the Construction phase, temporary access will be assessed to determine if it will be needed for Operations and Maintenance; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the road or trail condition. – Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally. – Disturbances related to inspection, maintenance and vegetation management will, for the most part, be contained within the existing ROW, already cleared during construction. – Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied as applicable and will be described in the EPP. – Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002. – Nalcor will decommission those access roads and trails used during construction that are not required for the Operations and Maintenance activities. – Ground travel for maintenance of the transmission line will be restricted to existing approved travel routes, which will be used and maintained in accordance with the applicable regulations. – Transmission line maintenance and repair personnel will adhere to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions. – Nalcor will implement a policy of no wildlife harvesting, no feeding, and no possession of firearms or pets by transmission line maintenance and repair personnel. – Only essential vehicular activity, including helicopter flights, will be permitted along the transmission line ROW to minimize disturbance to wildlife. – Nalcor will avoid conducting non-essential activity in Primary Core area in Newfoundland during the sensitive calving and post-calving season, to the extent feasible. – Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task. – Completing any inspections, maintenance and / or repairs as quickly and efficiently as safety allows. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products. – Well maintained equipment with quality mufflers will be used and equipment maintenance schedules will be followed. – Engine idling will be minimized and environmental awareness training with key maintenance and repair personnel will be conducted on this topic.
Furbearers	– Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002.

Table 12.6.1-2 Operations and Maintenance Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC	Proposed Mitigation
	– Ground travel within the ROW for inspection or maintenance of the transmission line will be restricted to existing and / or approved trails. These trails will be used and maintained in accordance with the applicable regulations. – Upon completion of the Construction phase, temporary access will be assessed to determine if it will be needed for Operations and Maintenance; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the road or trail condition. – Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally. – Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of riparian shoreline(s) will include regular inspection and maintenance of those structures. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Vegetation buffer zones, established at environmentally sensitive areas during construction, will be maintained. Only danger trees will be removed from these areas. – Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied as applicable and will be described in the EPP. – Transmission line maintenance and repair personnel will adhere to appropriate speed limits applicable to the size and class of the access roads to reduce the potential for vehicle-wildlife collisions. – Transmission line maintenance and repair personnel will not feed or harass wildlife. – Nalcor personnel and contractors will not interfere with traplines or associated equipment. – Only essential vehicular activity, including helicopter flights, will be permitted along the transmission line ROW to minimize disturbance to wildlife. – Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task. – Completing any inspections, maintenance and / or repairs as quickly and efficiently as safety allows. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products. – Well maintained equipment with quality mufflers will be used and equipment maintenance schedules will be followed. – Engine idling will be minimized and environmental awareness training with key personnel will be conducted on this topic.
Avifauna	– Access control measures (e.g., signage, gates) to address OHV use of access roads and trails required for Project Operations and Maintenance will be examined and discussed with NLDEC Wildlife Division, and applied as applicable and will be described in the EPP. – Upon completion of the Construction phase, temporary access roads will be assessed to determine if they will be needed for Operations and Maintenance; where access is to be decommissioned, the disturbed area will be returned to a comparable land use capability, depending on the trail's condition. – Upon completion of Construction, all disturbed areas (e.g., exposed mineral soils) and construction staging areas not required for Operations and Maintenance or access will be regraded to re-establish drainage patterns, blend with the natural terrain and allowed to revegetate naturally.

Table 12.6.1-2 Operations and Maintenance Mitigation Strategies and Methods – Terrestrial Environment (continued)

VEC	Proposed Mitigation
	– Ground travel within the ROW for inspection or maintenance of the transmission line will be restricted to existing and / or approved trails. These trails will be used and maintained in accordance with the applicable regulations. – Where access roads and trails require the installation of permanent watercourse crossing structures (e.g., bridges, culverts), the protection of riparian shoreline(s) will include regular inspection and maintenance of those structures. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Vegetation buffer zones, established at environmentally sensitive areas during construction, will be maintained. Only danger trees will be removed from these areas. – Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002. – Where possible, annual transmission line maintenance activities within 200 m of an active raptor nest will be scheduled to avoid the sensitive period for that species. – Only essential vehicular activity, including helicopter flights, will be permitted along the access and transmission line ROW to minimize disturbance to wildlife. – Transmission line maintenance and repair personnel will not feed or harass wildlife. – Adjacent to rivers that support breeding Harlequin Duck, Operations and Maintenance activities will not take place in the vicinity (e.g., 500 m) of breeding pair locations during May 1 to July 31. – Work within 200 m of an active raptor nest will occur only following discussion with provincial authorities, and may require one or more of the following: ▪ Only essential vehicular activity, including helicopter flights, and essential machinery and equipment will be permitted along the ROW and access to minimize disturbance to wildlife, including avifauna ▪ Work will not be conducted in these areas between June 1 and August 15, unless necessary ▪ Where work activity creates a disturbance at the nest site for a period of more than two (2) hours (e.g., adults leave the nest), crews will cease work and move a minimum of 200 m from the nest; work will not resume until activity at the nest has returned to normal for a period of two (2) hours ▪ Crews will not take lunch breaks within 200 m of an active raptor nest – Effective scheduling and logistics for maintenance work will be completed to minimize the number of vehicle trips per maintenance task, and any inspections, maintenance and / or repairs will be completed as quickly and efficiently as safety allows. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products. – Well maintained equipment with quality mufflers will be used and equipment maintenance schedules will be followed. – Engine idling will be minimized and environmental awareness training with key personnel will be conducted on this topic.

12.6.2 Species of Special Conservation Concern

A list of terrestrial species of conservation concern was presented in Table 10.5.11-1 (Chapter 10). This section summarizes how the protected species (i.e., those on SARA Schedule 1 (SARA 2011, internet site) or NLESA (GNL 2011, internet site) and those species listed by COSEWIC (COSEWIC 2011, internet site) or assessed by the provincial SSAC (NLDEC 2011a, internet site) that are likely to interact with the Project are addressed in this assessment. Table 12.6.2-1 indicates how such species are addressed, provides a brief description of the predicted likely effects, and an indication of the predicted significance of likely Project effects. Except for woodland caribou, the terrestrial species of special conservation concern were not evaluated separately. Consequently, except for woodland caribou no species-specific effects predictions and significance determinations have been made.

Table 12.6.2-1 Summary Effects: Species of Special Conservation Concern – Terrestrial Environment

Species of Concern[(a)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Vegetation			
Long's braya; Fernald's braya; Fernald's milk-vetch; Boreal felt lichen (boreal population)	Effects and mitigations captured as part of the Listed Plant KI under the Vegetation VEC	– Loss of individual Listed Plants as a result of clearing and soil disturbance during Construction, accidental spills and malfunctions, and increased OHV access – Loss or alteration of important habitat with the potential to support listed plants due to Construction – Potential fragmentation of important habitat during Construction may contribute to altered natural disturbance regimes and changes in environmental conditions leading to potential increases in the frequency of forest fires, outbreaks of defoliating insects, disease, pathogens and windthrow events over the life of the Project – During Project Operations and Maintenance Habitat Types will be maintained in an early successional stage – Improved OHV access to previously remote areas over the life of the Project could lead to the disturbance or loss of yet unknown individuals or populations of listed plants – Effects limited to less than 5% of known listed plant locations within the LSA, and will be evident over the life of the Project	Not significant

Table 12.6.2-1 Summary Effects: Species of Special Conservation Concern – Terrestrial Environment (continued)

Species of Concern[(a)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Caribou			
Woodland Caribou (Boreal population)	Effects and mitigations captured as part of the Caribou VEC	– Habitat loss or alteration and fragmentation to <5% of Caribou herd ranges due to Project Construction and lasting over the life of the Project – Potential for increased mortality due to vehicle-caribou collisions (direct), or resulting from increased access along the ROW, reduced forage availability ROW (indirect) during construction – Potential for changes in migration or movement routes during Construction – Temporary sensory disturbance and avoidance behaviour may be experienced during Construction activities beyond the LSA but within the RSA – Periodic sensory disturbance during Operations and Maintenance activities – Sensory disturbance due to increased access along the transmission lines will continue over the life of the Project – Project Operations and Maintenance will cause habitat alteration in <5% of caribou herd ranges – Project Operations and Maintenance may cause increased mortality (direct or indirect), reduced forage availability or access, and changes in migration and movement routes	Not significant
Furbearers			
Newfoundland Marten (American Marten Newfoundland population)	Effects and mitigations captured as part of the Marten KI under the Furbearer VEC	– Minimal reduction in primary habitat along the ROW (<1% of primary habitat present within the RSA) and habitat fragmentation due to clearing, for the life of the Project – Sensory disturbance of some individuals during construction and Operations and Maintenance due to increased human activity, likely extending into the RSA	Not significant

Table 12.6.2-1 Summary Effects: Species of Special Conservation Concern – Terrestrial Environment (continued)

Species of Concern[(a)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Avifauna			
Harlequin Duck	Effects and mitigations captured as part of the Waterfowl KI under the Avifauna VEC	– Minimal reduction in habitat (1% or less of the wetland waterfowl habitat available in the RSA is affected) along the ROW for the life of the Project – Temporary sensory disturbance during Project Construction or Operations and Maintenance activities, likely extending into the RSA – Potential for Waterfowl mortality during construction if conducted during the most sensitive periods (i.e., breeding, nesting and rearing) – Potential for Waterfowl mortality during Operations and Maintenance due to interaction with high voltage transmission lines and increased hunting pressure due to increased access along the ROW – Effects occur periodically in conjunction with maintenance schedule and season (e.g., migration) and intermittently due to increased access or wildlife behaviour	Not significant
Red Crossbill *percna* subspecies	Effects and mitigations captured as part of the Passerines KI under the Avifauna VEC	– Minimal reduction in habitat (<1% of the primary habitat available for Passerines in the RSA is affected) along the ROW for the life of the Project – Temporary sensory disturbance during Project Construction or Operations and Maintenance activities, likely extending into the RSA – Potential for passerine mortality during construction if conducted during the most sensitive periods (i.e., breeding, nesting and rearing) – Potential for passerine mortality during Operations and Maintenance due to interaction with high voltage transmission lines along the ROW – Effects occur periodically in conjunction with maintenance schedule and season (e.g., migration) and intermittently due to increased access or wildlife behaviour	Not significant

Table 12.6.2-1 Summary Effects: Species of Special Conservation Concern – Terrestrial Environment (continued)

Species of Concern[(a)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Olive-sided Flycatcher	Effects and mitigations captured as part of the Passerines KI under the Avifauna VEC	– Minimal reduction in habitat (<1% of the primary habitat available for Passerines in the RSA is affected) along the ROW for the life of the Project – Temporary sensory disturbance during Project Construction or Operations and Maintenance activities, likely extending into the RSA – Potential for passerine mortality during construction if conducted during the most sensitive periods (i.e., breeding, nesting and rearing) – Potential for passerine mortality during Operations and Maintenance due to interaction with high voltage transmission lines along the ROW – Effects occur periodically in conjunction with maintenance schedule and season (e.g., migration) and intermittently due to increased access or wildlife behaviour	Not significant
Rusty Blackbird	Effects and mitigations captured as part of the Passerines KI under the Avifauna VEC	– Minimal reduction in habitat (<1% of the primary habitat available for passerines in the RSA is affected) along the ROW for the life of the Project – Temporary sensory disturbance during Project Construction or Operations and Maintenance activities, likely extending into the RSA – Potential for passerine mortality during construction if conducted during the most sensitive periods (i.e., breeding, nesting and rearing) – Potential for passerine mortality during Operations and Maintenance due to interaction with high voltage transmission lines along the ROW – Effects occur periodically in conjunction with maintenance schedule and season (e.g., migration) and intermittently due to increased access or wildlife behaviour	Not significant

Table 12.6.2-1 Summary Effects: Species of Special Conservation Concern – Terrestrial Environment (continued)

Species of Concern[(a)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Grey-cheeked Thrush	Effects and mitigations captured as part of the Passerines KI under the Avifauna VEC	– Minimal reduction in habitat (<1% of the primary habitat available for Passerines in the RSA is affected) along the ROW for the life of the Project – Temporary sensory disturbance during Project Construction or Operations and Maintenance activities, likely extending into the RSA – Potential for Passerine mortality during Construction if conducted during the most sensitive periods (i.e., breeding, nesting and rearing) – Potential for passerine mortality during Operations and Maintenance due to interaction with high voltage transmission lines along the ROW – Effects occur periodically in conjunction with maintenance schedule and season (e.g., migration) and intermittently due to increased access or wildlife behaviour	Not significant
Short-eared Owl	Effects and mitigations captured as part of the Raptors KI under the Avifauna VEC	– Minimal reduction in habitat (<1% of the primary habitat available for raptors in the RSA is affected) along the ROW for the life of the Project – Temporary sensory disturbance during Project Construction or Operations and Maintenance activities, likely extending into the RSA – Potential for Raptor mortality during Construction if conducted during the most sensitive periods (i.e., breeding, nesting and rearing) – Potential for Raptor mortality during Operations and Maintenance due to interaction with high voltage transmission lines along the ROW – Effects occur periodically in conjunction with maintenance schedule and season (e.g., migration) and intermittently due to increased access or wildlife behaviour	Not significant

Table 12.6.2-1 Summary Effects: Species of Special Conservation Concern – Terrestrial Environment (continued)

Species of Concern[(a)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Common Nighthawk[(b)]	Effects and mitigations captured as part of the Other Species of Special Conservation Status KI under the Avifauna VEC	– Minimal reduction in habitat (<1% of the primary habitat available for Common Nighthawk in the RSA is affected) along the ROW or the life of the Project – Temporary sensory disturbance during Project Construction or Operations and Maintenance activities, likely extending into the RSA – Potential for Raptor mortality during construction if conducted during the most sensitive periods (i.e., breeding, nesting and rearing) – Potential for Raptor mortality during Operations and Maintenance due to interaction with high voltage transmission lines along the ROW – Effects occur periodically in conjunction with maintenance schedule and season (e.g., migration) and intermittently dueto increased access or wildlife behaviour	Not significant

(a) Only Species of Special Conservation Concern (SSCC) that are likely to be present within the terrestrial study areas are included in this analysis. See Section 10.3.7 and Table 10.5.11-1 (Existing Environment) for information about species presence.

(b) Red Knot *rufa* subspecies, also a species of special conservation status identified in Table 10.5.11-1 has been assessed as part of the Migrating Shorebirds KI under the Seabirds VEC. See Sections 14.4.3.2 and 14.4.5.3.

Based on the planned Construction practices, Operations and Maintenance protocols, and mitigation measures to be implemented as part of the Project, environmental effects on terrestrial species of special concern as a result of Project are predicted to be of low magnitude, local to regional geographic extent, and short-term to far-future duration. The Project effects, including cumulative effects, are not predicted to affect populations, distributions patterns, densities or activities (e.g., nesting, feeding, migration) of species at a regional scale, and are not likely to be significant, with the excpetion of the RWMH Caribou. The Project interaction with the RWMH is limited to the south-eastern portion of the RWMH range. The effects of the Project are not expected to result in a further decline of this herd, and the Project effects relative to baseline are not significant. In recognition of the present status of this herd, and that other activities and pressures such as poaching and predation may continue, the overall fate is likely one of continued decline with or without the Project. If these existing (pre-Project) factors remain unchecked, the cumulative environmental effects are predicted to be significant, and not a result of the Project effects.

12.6.3 Accidents and Malfunctions

Chapter 5 identifies and describes potential incidents (i.e., accidents and malfunctions) related to Project Construction, and Operations and Maintenance. It also describes the potential environmental consequence (i.e., magnitude, extent, and duration) of these incidents and their likelihood of occurrence. The risk of each incident, a function of both probability of occurrence and environmental consequence, was then assessed as low, moderate or high.

Incidents that are considered to have low risk (i.e., have a low to high probability of occurrence, and a low consequence) are assessed as part of the environmental effects assessment for affected terrestrial VECs in this chapter. Incidents that are considered to have a moderate to high risk and have potential effects on the terrestrial environment are addressed in this section. Table 12.6.3-1 lists the moderate to high risk incidents that may affect the terrestrial environment. Table 12.6.3-1 also summarizes the likely effects of the incident and describes the prevention and response measures that will be implemented. These moderate to high risk incidents are unlikely to occur in the Terrestrial Environment and, therefore, effects are not likely to be significant.

Table 12.6.3-1 Summary of Potential Moderate to High Risk Incidents that Could Affect the Terrestrial Environment

Description of Incident	Likely Effects on the Terrestrial Environment	Prevention and Response Measures
Large spill (e.g., 1,000 L) of diesel fuel during construction that spills over the ground and into a watercourse	– Direct wildlife mortality – Loss or alteration and fragmentation of wildlife habitat – Loss or alteration of vegetation cover – Soil contamination	– The Safety, Health and Environment Emergency Response Plan (SHERP) will contain a spill prevention and response plan – The Environmental Protection Plan (EPP) will contain conditions for fuel handling and storage, including procedures for spill response – Spill kits will be available at all work sites. – A spill response team will be formed and trained prior to construction – Spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act* – Fuelling or servicing will not be permitted within 50 m of a waterbody – Biodegradable lubricants and hydraulic fluids will be used, where practical, when working near waterbodies – Fuels and oils will be stored at least 100 m from any surface water – Converter station sites will be surrounded by a constructed berm or dyke to prevent release of transformer oils or other substances into the environment
Large forest fire in Labrador, originating along the access roads or ROW, during the summer.	– Direct wildlife mortality – Loss or alteration and fragmentation of wildlife habitat – Loss or alteration of vegetation cover – Alteration of soil quality	– Adherence to terms and conditions of Operating Permits issued by the Forest Services Branch – The SHERP will contain a fire prevention plan – The EPP will contain forest fire prevention measures and a fire response plan – Firefighting equipment will be available at each work site – In the event of a forest fire, steps will be taken to extinguish the fire (if safe to do so), and the fire will be reported to the provincial Forest Services Branch
Forest fire in the vicinity of a populated community in Newfoundland, originating along the access roads or ROW, during the summer.	– Direct wildlife mortality – Loss or alteration and fragmentation of wildlife habitat – Loss or alteration of vegetation cover – Alteration of soil quality	– Adherence to terms and conditions of Operating Permits issued by Forest Services Branch – The SHERP will contain a fire prevention plan – The EPP will contain forest fire prevention measures and a fire response plan – Firefighting equipment will be available at each work site – In the event of a forest fire, immediate steps will be taken to extinguish the fire (if safe to do so), and the fire will be reported to the provincial Forest Services Branch

The following sections provide a description of the conditions or activities that could lead to each incident, the potential effects of the incident on the terrestrial environment, description of prevention and mitigation measures that will be implemented, and the likely residual effects after mitigation and their significance. Additional information on each incident is provided in Chapter 5.

Large spill (1,000 L) of diesel fuel during construction that spills over the ground and into a watercourse.

Description of Incident

During Project Construction, and Operations and Maintenance, environmentally hazardous materials such as hydrocarbons (e.g., gasoline and diesel), lubricating oils and hydraulic fluid will be used. Diesel fuel for the re-fuelling of heavy equipment will be transported in a 1,000 L portable fuel storage tank. There is a potential that this fuel tank is breached due to a mishap (e.g., roll over), and that up to 1,000 L of diesel fuel spills over the ground.

Likely Effects of Incident on the Terrestrial Environment

A spill of diesel fuel could result in the mortality of avifauna, mammals and amphibians, through direct contact with the spilled fuel or consumption of the receiving waters. Vegetation may be lost or altered due to contact with the spilled fuel, which could, in turn, result in wildlife habitat loss, alteration and fragmentation. Soil contamination may render soils unsuitable for plant growth. As most of these effects result from direct contact with the spilled fuel, the terrestrial effects of a diesel fuel spill are likely to occur in the vicinity of the spill. Some effects may be felt downstream from the spill, as wildlife and riparian vegetation come into contact with the receiving waters.

Summary of Prevention and Response Measures

The SHERP will include specific instructions for the prevention of and response to spills or leaks of hazardous materials. The EPP will also contain material handling and storage measures and the spill response plan. Spill response kits will be maintained at all work sites, and spill kit contents will be based on the volume of fluids in use, the type of fluid, proximity to water and other relevant factors. All personnel involved in hydrocarbon transport and transfer will be trained in spill response. A Response Team will be formed, trained and will receive regular practice in “mock” responses for incidents that require co-ordinated action. Any spills in excess of the amount, concentration, level, or rate of release authorized by the *NLEPA* or any Project approvals granted under the *NLEPA* will be reported to the NLDEC.

All mobile storage tanks will be registered under, and comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* Records will be maintained of all storage tank contents to reconcile inventories as a check against undetected leakage. All transport vehicles will be licensed and maintained according to safety requirements. Fuelling or servicing of mobile equipment will not be permitted within 50 m of a waterbody. Biodegradable lubricants and hydraulic fluids will be used where practical when working near waterbodies. Further, appropriate storage and handling of fuels and hazardous or controlled products will include storing fuels and oils at least 100 m away from any surface water. Berms will be constructed at converter sites as transformer oils and other substances will be stored at these locations.

Large forest fire in Labrador, originating along the access roads or ROW, during the summer, or forest fire in the vicinity of a populated community in Newfoundland, originating along the access roads or ROW, during the summer.

Description of Incident

The operation of combustion engines (e.g., vehicles, heavy equipment, chainsaws), blasting activity and workers smoking have the potential to ignite forest fires. Both combustion engines and workers are expected to be present during most Project Construction, and Operations and Maintenance activities, and blasting may occur during foundation construction. Several Project activities will occur in forested areas where the ignition source could lead to a forest fire.

Given the Forest Services Branch's policy not to fight fires that do not threaten communities or harvestable resources, a forest fire in Labrador could affect large tracts of land. A large forest fire in Labrador is considered to cover an area of approximately 470 ha (the average extent of forest fires in Labrador) or more. A similar fire in Newfoundland would be more actively fought but has a greater likelihood of approaching a populated community.

Likely Effects of Incident on the Terrestrial Environment

The effects of a forest fire on the terrestrial environment would include the direct mortality of wildlife and the loss or alteration of vegetation and forest cover. Changes in vegetation would, in turn, result in wildlife habitat alteration, loss and fragmentation. Most fires within Labrador do not generate a suppression response due to their remoteness, while most fires are actively suppressed on the more densely populated Island. It is therefore likely that the effects of a forest fire on the terrestrial environment in Labrador would be more widespread than those of a forest fire in Newfoundland. The average extent of forest fires on the Island is less than 3.5 hectares (ha) compared with the average 470 ha fire in Labrador.

Forest fires reduce the availability of freshly fallen or partly decomposed organic material on the forest floor. This, in turn, affects the soil's capacity to retain water and nutrients. The heat from the fire can also affect the micro-organisms that decompose organic wastes in the soil.

In the longer term, forest fire leads to secondary succession (i.e., when one plant community supplants another). Secondary succession may involve the regeneration of the same species, a complete change of species, or a diversification of species. Some species (e.g. birch, aspen) easily establish in burned areas, where they are able to benefit from the increased availability of sunlight. Other species (e.g., blueberries) prefer burned areas and gradually disappear as the forest cover is re-established (NRCan 2011, internet site).

Summary of Prevention and Response Measures

The SHERP will include a plan for fire prevention. The EPP will also contain fire prevention measures and the fire response plan. All Project personnel will be made aware of the SHERP and designated staff will receive SHERP training. The forest fire prevention plan will be followed by Nalcor and its contractors. Forest fire prevention measures addressed in the SHERP and EPP will include the storage and disposal of flammable material, the use of designated smoking areas, and the prohibition of burning brush or debris.

Detailed information on firefighting equipment and procedures will be provided in the SHERP, the EPP and other environmental documents, such as terms and conditions of permits and authorizations. Firefighting equipment, as described in Chapter 5, that is suitable to the labour force and working conditions will be available at each work site and will be in proper working condition, as required by the Operating Permit obtained from the Forest Services Branch. In the event of a forest fire, immediate steps will be taken to contain or extinguish the fire to the extent practical and safe, and fires will be reported immediately to the nearest regional office of the Forest Services Branch, the branch of government responsible to coordinate the province's fire suppression program.

Summary of Assessment of Moderate to High Risk Accidents and Malfunctions

The likely effects of the release of a large amount of diesel fuel or other hazardous material or a large forest fire in Labrador or a forest fire in the vicinity of a community in Newfoundland on the Terrestrial Environment during Project Construction or Operations and Maintenance include direct wildlife mortality, loss of vegetation cover and alteration or fragmentation of habitat, and soil contamination. Nalcor will implement leak and spill prevention measures and fire prevention measures in accordance with relevant regulations, and adhere to conditions of relevant permits. Spill kits, firefighting equipment, and trained personnel will be onsite and, if necessary, the spill or fire response plan outlined in the SHERP (see Section 5.10.1) and the EPP will be implemented. Consequently, hazardous materials release events and forest fires will be prevented to the extent possible. Spills or forest fires that do occur will be dealt with quickly to reduce the spread of hazardous materials or fire, and the consequent loss of wildlife and loss or alteration of wildlife habitat.

Prevention and response measures are in place and these moderate to high risk spill or forest fire incidents are unlikely to occur; therefore, the effects are not likely to be significant.

12.6.4 Residual Project Effects and Significance

The environmental effects assessment framework focuses the assessment on important and likely issues and interactions and considers the overall ecological context. The framework integrally reflects ecological and socioeconomic interrelationships between VECs, others aspects of the natural and human environments, and associated Project related issues as indicated in the interaction tables. The ELC forms the basis of the terrestrial environment assessment, representing the vegetation, soils, hydrological and physical land characteristics and habitats that support a wide variety of plant and wildlife species including listed species, and the interrelationships between them. Nalcor's attention to sustainability as fundamental to the assessment also reflects the intent to respect ecosystem integrity, including the capability of natural systems to maintain their structures and functions, and to support biological diversity; and the EIS integrally considers the extent to which terrestrial biological diversity is affected by the Project. This section summarizes the residual Project effects on the Terrestrial Environment and their significance.

Nalcor will continue to consider possible Project interactions with the Terrestrial Environment during Project planning, and will have effects management measures in place to minimize residual Project effects on the Terrestrial Environment during both Construction and Operations and Maintenance phases as presented in Tables 12.6.1-1 and 12.6.1-2. Among others, these measures include compliance with existing provincial and federal legislation (e.g., *Forestry Act, Environmental Protection Act, Migratory Birds Convention Act*), avoidance of environmentally sensitive sites (e.g., listed plant habitat, wetlands, core caribou habitat, known marten core habitat, raptor nest sites) where feasible, use of existing ROWs and disturbances where possible, maintaining appropriate buffers, implementing access control measures, and developing species-specific mitigation measures where necessary and appropriate. Nalcor's plan to conduct site-specific surveys during detailed ROW planning as necessary and appropriate, continue communication with NLDEC regulators, and contingency and response measures included in the EPP to address issues that do arise, will help to minimize adverse interactions with the Terrestrial Environment.

The likely residual effects of Project Construction, and Operations and Maintenance activities on Vegetation includes loss or alteration and degradation of habitat due to vegetation clearing, soil disturbance, drainage alteration and accidental release of contaminants, resulting in site-specific contamination, alteration of wetland form or function or riparian shoreline due to unavoidable disturbance during Construction, introduction and spread of non-native or invasive species from equipment or vehicles entering the Project work sites, loss of habitat to support listed or regionally uncommon plants due to clearing or disturbance (e.g., at L'Anse au Diable electrode site), potential loss of timber resources due to forest fire, and similar effects as a result of vegetation management or major repair activities during Operations and Maintenance. These habitat changes are likely to affect less than 5% of available habitat types or merchantable timber resources that occur within the LSA. Therefore, the Project is not likely to result in significant adverse environmental effects on the Vegetation VEC.

The likely residual effects of Project Construction, and Operations and Maintenance activities on Caribou include habitat loss or alteration due to vegetation clearing, possible mortality directly due to collisions with vehicles or indirectly as a result of sensory disturbance and avoidance of human activity up to 250m from Project activities or during Construction or Operations and Maintenance, a reduction in forage availability or access, and changes to migration or movement patterns. Less than 5% of caribou herd ranges in Labrador or caribou Primary Core areas in Newfoundland will be exposed to the effects of Construction and Operations and Maintenance. These are not predicted to affect the viability or recovery of woodland caribou populations in Central and Southeastern Labrador and Newfoundland. Therefore, the Project is not likely to result in significant adverse environmental effects on the Caribou VEC.

The likely residual effects of Project Construction, and Operations and Maintenance activities on Furbearers include habitat loss, alteration or fragmentation due to vegetation clearing, possible mortality directly due to collisions with vehicles or indirectly as a result of sensory disturbance and avoidance of human activity from Project activities during Construction or Operations and Maintenance, and increased mortality due to hunting or trapping pressure associated with increased access along the ROW. As well as the adverse effects, the Project has the potential to increase the amount of suitable habitat for Red Fox (i.e., maintenance of semi-open habitat during Operations and Maintenance), and maintenance activities along the ROW and at other Project related facilities are not likely to have an adverse effect on Red Fox or Beavers, species that are relatively tolerant of human activities. The Project is predicted to affect only a small portion of available Furbearer habitat within the RSA, and to have no measurable effect on the regional distributions or populations of Furbearer species. Therefore, the Project is not likely to result in significant adverse environmental effects on the Furbearers VEC.

The likely residual effects of Project Construction, and Operations and Maintenance activities on Avifauna include loss or alteration of primary habitat due to vegetation clearing or wetland disturbance, sensory disturbance due to noise and avoidance of human activity during Construction or Operations and Maintenance depending on species tolerance to human activities and seasonal timing of activity, increased mortality due to collisions with motor vehicles or electrocution from interaction with high voltage transmission lines. Individual animals may be displaced for the short- to medium-term, depending on the activity type, but the regional distribution of Avifauna is not predicted to be affected. The loss of less than 1% of the primary habitat available for Avifauna in the RSA is predicted to have a small measurable effect on habitat availability at the local scale and little, if any, effect at the regional scale. Therefore, the Project is not likely to result in significant adverse environmental effects on the Avifauna VEC.

Table 12.6.4-1 provides a summary of the VECs selected for the Terrestrial Environment, and the significance of the predicted effects.

Table 12.6.4-1 Summary: Significance of Effects on Terrestrial Valued Environmental Components

VEC	Likely Significant Effect	Comment
Vegetation	No	The effects of the Project on the Vegetation Abundance and Diversity, Wetlands, Riparian Shoreline, Listed Plants, Regionally Uncommon Plants, and Timber Resources are not likely to affect any Vegetation KIs such that their continued contribution to ecosystem function within the LSA and the RSA are not sustainable
Caribou	No	The effects of the Project on woodland caribou are not likely to cause a population decline, such that the viability or recovery of woodland caribou populations in Central and Southeastern Labrador and Newfoundland is threatened
Furbearers	No	The effects of the Project on Marten, Red Fox, Porcupine and Beaver are not likely to result in a decline in the numbers of animals such that a population cannot be maintained within the RSA or in any of the Project regions
Avifauna	No	The effects of the Project on Waterfowl, Passerines, Raptors, Upland Game Birds or Other Species of Special Conservation Status are not likely to cause a population decline for any of the Avifauna KIs or representative species / guilds therein, such that the viability of that population is threatened

While the Project is likely to have residual effects on the Terrestrial Environment as represented by the VECs assessed, effects will be within the capacity of the environment. The Project will not adversely affect the viability of Vegetation such that its continued contribution to ecosystem function is not sustainable, or threaten the viability of Furbearer or Avifauna populations such that they cannot be sustained, or threaten the viability or recovery of woodland caribou populations in Central and Southeastern Labrador and Newfoundland. Consequently, Project effects on the Terrestrial Environment are likely to be not significant.

12.6.5 Cumulative Environmental Effects

The cumulative effects assessment considered the overall effect on the Terrestrial Environment (Vegetation, Caribou, Furbearer, and Avifauna VECs) as a result of the Project's likely residual environmental effects in combination with those of other projects and activities that have been or will be carried out. The existing environment considers all projects and activities that have been undertaken in the past, or are ongoing. The future projects and activities considered for the cumulative effects assessment included those with likely overlapping environmental effects within the RSA. Reasonably foreseeable future projects and activities considered in the cumulative effects assessment for the Terrestrial Environment include the Lower Churchill Hydroelectric Generation Project, the TransCanada Highway Phase 3 development and 5 Wing Goose Bay Military Flight Training in Labrador, commercial forest harvesting, general economic development, oil and gas exploration and drilling in the Northern Peninsula, and other land uses, particularly OHV use.

Vegetation

Potential cumulative effects on the Vegetation VEC in all regions of the proposed Project include loss or alteration of habitat as a result of clearing, displacement of native vegetation from the introduction or spread of non-native and invasive species, and vegetation disturbance or loss due to increased OHV use. The vegetation in Southeastern Labrador and the Northern Peninsula remains largely in a natural state; as one moves south on the Island, the vegetation has been influenced by the development of roads, transmission lines and communities, and timber harvesting.

The contribution of the Project to cumulative environmental effects on Vegetation will extend through the life of the Project, but will be minimal compared with the overall contribution to cumulative effects of other projects and activities. The proposed Project and other projects and activities have mitigation measures in place to minimize adverse effects and access control measures will be implemented for the Project to address increased public OHV use. Cumulative effects on Vegetation are determined to be low in magnitude and not significant.

Caribou

Potential cumulative effects on woodland caribou in Labrador and the Island relate primarily to landscape disturbances (e.g., fragmentation) from ongoing commercial forestry and other activities and projects. Landscape disturbances, including habitat loss or alteration due to clearing and / or the introduction or spread of non-native and invasive species, as well as alteration or disturbance of movement routes, sensory disturbance, and increased access and subsequent OHV use, have the potential to cause the direct and indirect loss of caribou habitat and additional risk of mortality of individuals due to predation and hunting.

Implementation of effective mitigation measures including use of existing disturbances and avoiding primary caribou habitat (i.e., caribou range in Labrador and Primary Core area in Newfoundland) to the extent practical, and access management, as well as continuing support of LWCRT's recovery strategy and monitoring programs to evaluate effectiveness of mitigations, will help to minimize the cumulative effects associated with the Project in combination with other projects and activities. Nalcor's implementation of these mitigations for the proposed Project and continued participation in monitoring efforts are expected to limit the overall contribution of the Project to cumulative effects on the RWMH and MMH in Labrador and the caribou population in Newfoundland.

The Project interaction with the RWMH is limited to the south-eastern portion of the RWMH range. The effects of the Project are not expected to result in a further decline of this herd, and the Project effects relative to baseline are not significant. In recognition of the present status of this herd, and that other activities and pressures such as poaching and predation may continue, the overall fate is likely one of continued decline with or without the Project. If these existing (pre-Project) factors remain unchecked, the cumulative environmental effects are predicted to be significant, and not a result of the Project effects.

The MMH in Labrador and Newfoundland caribou population are predicted to remain viable, and cumulative effects are determined to be not significant.

Furbearers

Cumulative effects on the Furbearers VEC in all regions of the proposed Project include the loss or alteration of habitat, temporary disturbance, increased access, and changes to small mammal prey densities. Current populations of the Furbearer VEC species are generally healthy, although marten populations in the Northern Peninsula and Central and Eastern Newfoundland are feeling pressure from logging and trapping activities. Access is expected to increase with the proposed Project in combination with other projects and activities, with the subsequent potential for furbearer mortality due to increased trapping. However, the cumulative effects are not expected to affect the Furbearer VEC populations on a regional basis.

The contribution of the Project to cumulative environmental effects on Furbearers will be minimal compared with the overall contribution to cumulative effects of other projects and activities. Nalcor will implement access control measures for the Project to address increased public OHV use. Cumulative effects are determined to be low in magnitude and not significant.

Avifauna

Cumulative effects on the Avifauna VEC in all regions of the proposed Project include habitat alteration or loss and fragmentation as a result of clearings and roads created by the Project and other developments, particularly forestry activities, as well as sensory disturbance and increased hunting pressure as a result of increased public OHV access. Current avian populations including listed species are considered stable, although the concentration of human development in the Avalon Peninsula with the associated habitat alteration or loss has some influence on populations in the region.

The contribution of the Project to cumulative environmental effects on the Avifauna VEC will extend through the life of the Project, but will be limited in scale to the LSA or potentially the RSA (relative to OHV access), low in magnitude, and minimal compared with the overall contribution to cumulative effects of other projects and activities. Nalcor will implement access control measures for the Project to address increased public OHV use of the Project ROW, roads and trails. This, in conjunction with general decline in forestry activities on the Island, will limit the potential for cumulative effects. Cumulative effects on Avifauna are determined to be low in magnitude and not significant.

12.6.6 Environmental Monitoring and Follow-up

Monitoring and follow-up programs are proposed for a variety of vegetation, wildlife and avifauna species of special conservation concern as outlined below. As well, during Project Construction and routine inspections during Operations and Maintenance which will be conducted from the ground or the air, Nalcor will note any areas of environmental concern related to vegetation (e.g., erosion, poor vegetation establishment, weeds) and incidents related to effects on wildlife and avifauna species (e.g., vehicle collisions, electrocutions, unauthorized access and resulting disturbance presence of nests on transmission towers or poles). Nalcor will address any issues that become apparent through their follow-up studies, monitoring and inspection programs appropriately through their adaptive management process.

Vegetation

In consultation with Environment Canada and the NLDEC Wildlife Division, Nalcor proposes to design a follow-up program to target known locations of listed plant species and their important habitats, coupled with a review of OHV use facilitated by the Project. As described in Section 12.2.10, this will include evaluating the success of mitigation efforts undertaken to protect listed plants during Project Construction and developing a reclamation strategy or other mitigation as appropriate.

Caribou

As an LWCRT member, Nalcor will continue to support research to further understanding of the threatened Central and Southeastern Labrador woodland caribou population, as described in Section 12.3.10. Specifically, Nalcor will work with the NLDEC to develop an effective monitoring program to support the RWMH population, and work with all stakeholders to monitor and control access and deter illegal hunting.

Furbearers

Two follow-up studies are proposed for the Furbearers VEC. The first program, focused on the effects of ROW construction and operation on marten habitat use, is described in Section 12.4.9 and would be conducted in the Main River core area. If modified vegetation management techniques are adopted to help facilitate marten movement across the ROW, Nalcor would work with the Wildlife Division to design an appropriate study to investigate their effectiveness.

Also as described in Section 12.4.9, the second program would use aerial surveys to investigate public access by snowmobiles along the ROW and access roads as a result of the Project during the first winter following Project Construction. This program would assess the effectiveness of access control measures, as well as whether sensitive areas such as marten core areas are being accessed via the ROW. The results would be used to adjust Nalcor's access control measures and help minimize the likely adverse effects of the Project on Furbearers.

Avifauna

As described in Section 12.5.10, prior to Project Construction commencement Nalcor will conduct a study to evaluate the presence of breeding pairs of Harlequin Duck on rivers that are affected by the Project and known to support this species, to determine the extent of breeding activities. Survey results will be used to design mitigation as appropriate in Labrador and to assist in selection of the final alignment in Newfoundland. Immediately following Project Construction and for a period of two years following commencement of Operations and Maintenance, follow-up surveys will be conducted to verify the predicted likely effects of the Project on breeding pairs of Harlequin Duck.

Also as described in Section 12.5.10, a follow-up program to determine nesting success of Osprey and Bald Eagle will be developed if nests identified within the LSA prior to Project Construction were relocated as a result of vegetation clearing activities.

12.7 References

ACCDC (Atlantic Canada Conservation Data Centre). 2008. Rarity Ranks and Legal Status by Province. Data obtained for the Study Area in 2008. Available at: http://accdc.com/home_nl.html. Accessed: September 2008.

ACCDC. 2010. Rarity Ranks and Legal Status by Province. Updated October 2010. Available at: http://www.accdc.com/Products/ranking.html. Accessed: October 2010.

Adair, W.A. and J.A. Bissonette. 1997. An Energetic-based Habitat Model for Marten in Western Newfoundland. Western Newfoundland Model Forest. Report Number 2-207-004.

AGRA Earth and Environmental Ltd. and Harlequin Enterprises. 1999. Churchill River Power Project: LHP98-01 Waterfowl, Final Report. Unpublished report prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Aleksiuk, M. 1968. Scent mound communication, territoriality, and population regulation in beaver (*Castor canadensis*). J. Mammalogy 49:759-762.

Allen, A.W. 1983. Habitat Suitability Index Models: Beaver. US Fish and Wildlife Service, FWS/OBS-82/10.30 Revised. 20 pp.

Altman, B. and R. Sallabanks. 2000. Olive-sided Flycatcher (*Contopus cooperi*). In A. Poole (ed.). The Birds of North America Online, Ithaca: Cornell Lab of Ornithology. Retrieved from the Birds of North America Available at: http://bna.birds.cornell.edu/bna/species/502.

Ammon, E.M. 1995. Lincoln's Sparrow (*Melospiza lincolnii*). In A. Poole and F. Gill (eds.). The Birds of North America, No. 191. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, DC.

Anderson. W. 1978. Waterfowl collisions with power lines at a coal-fires power plant. Wildlife Society Bulletin. 6(2): 77-83.

Angold, P.G. 1997. The Impact of a Road upon Adjacent Heathland Vegetation: Effects on Plant Species Composition. Journal of Applied Ecology 34:409-417.

ANPC (Alberta Native Plant Council). 2006. ANPC Guidelines for Rare Plant Surveys in Alberta. Available at: http://www.anpc.ab.ca/content/index.php. Accessed: March 2012.

APLIC (Avian Power Line Interaction Committee). 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute, Washington, D.C.

APLIC (Power Line Interaction Committee) and USFWS (U.S. Fish and Wildlife Service). 2005. Avian Protection Plan (APP) Guidelines.

Arcese, P., M.K. Sogge, A.B. Marr and M.A. Patten. 2002. Song Sparrow (*Melospiza melodia*). In A. Poole (ed.) The Birds of North America Online. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Available at: http://bna.birds.cornell.edu/bna/species/591.

Baker, J.M., R.B. Clark and P.F. Kingston. 1991. Two Years after the Spill: Environmental Recovery in Prince William Sound and the Gulf of Alaska. Institute of Offshore Engineering, Heriot-Watt University, Edinburgh, UK.

Barrett, G.C. and D.V. Weseloh. 2008. Bird Mortality Near High Voltage Transmission Lines in Burlington and Hamilton, Ontario, Canada. In J.W. Goodrich-Mahoney, L.P. Abrahamson, J.L. Ballard and S.M. Tikalsky (ed.). Environmental Concerns in Rights-of-Way Management: Eighth International Symposium.

Bender, D.J. and R.M. Brigham. 1995. Preliminary Inventory Manual for Sampling Goatsuckers (*Caprimulgidae*) in British Columbia. Resource Inventory Committee. Ministry of Environment, Wildlife Branch.

Bengston, S. 1972. Breeding Ecology of the Harlequin Duck *Histrionicus histrionicus* (L.) in Iceland. Ornis Scandinavica. 3(1): 1-19.

Benítez-López, A., R. Alkemade and P.A. Verweij. 2009. Are Mammal and Bird Populations Declining in the Proximity of Roads and Other Infrastructure? Systematic Review No. 68. Collaboration for Environmental Evidence.

Berger, R.P. 1995. Fur, Feathers, and Transmission Lines: How Rights of Way Affect Wildlife. Prepared for Manitoba Hydro, 2nd Edition, July 1995. 62pp.

Bergerud, A.T. 1967. Management of Labrador caribou*. Journal of Wildlife Management* 31: 626-642.

Bergerud, A.T. 1974. Decline of Caribou in North America following Settlement. Journal of Wildlife Management 38: 757-770.

Bergerud, A.T. 1996. Evolving Perspectives on Caribou Population Dynamics, Have We Got it Right Yet? Rangifer, Special Issue No. 9: 95-116.

Bergerud, A.T., R.D. Jakimchuk and D.R. Carruthers. 1984. The Buffalo of the North: Caribou (*Rangifer tarandus*) and Human Developments. *Arctic* 37: 7-22.

Bergerud, A.T., S.N. Luttich and L. Camps. 2008. The Return Of Caribou to Ungava. McGill-Queens University Press, Montreal, QC and Kingston, ON.

Bevanger, K. 1998. Biological and Conservation Aspects of Bird Mortality Caused by Electricity Power Lines: A Review. Biological Conservation, 86 (1): 67-76.

Bevanger, K. and H. Brøseth. 2004. Impact of Power Lines on Bird Mortality in a Subalpine Area. Animal Biodiversity and Conservation. 27(2): 67–77.

Bighorn Environmental Design Ltd. 1996. Cumulative Effects and Environmental Assessment of the Proposed Cheviot Mine Development: Ungulates, Small Mammals, Avifauna, Amphibians. Prepared for Cardinal River Coals Ltd., Hinton, AB.

Bissonette, J.A., R.J. Frederickson and B.J. Tucker. 1988. The Effects of Forest Harvesting on Marten and Small Mammals in Western Newfoundland. Prepared for the Newfoundland and Labrador Wildlife Division and Corner Brook Pulp and Paper, Corner Brook, NL. et al. 1988.

Blake, J. 2006. Coyotes in Insular Newfoundland: Current Knowledge and Management of the Islands Newest Mammalian Predator. Document produced for the Department of Environment and Conservation, Government of Newfoundland and Labrador, St. John's, NL. Available at: http://www.env.gov.nl.ca/env/publications/wildlife/51f40a0ed01.pdf.

Blake, J. 2011a. Director, Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador. 2011 Letter to S. Bonnell (Environmental Assessment Lead (Transmission), Nalcor). Re: Labrador-Island Transmission Link Environmental Assessment: Newfoundland and Labrador Woodland Caribou Information. Includes digital presentation, caribou locational information. March 1, 2011.

Blake, J. 2011b. Director, Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador. Email. May 24, 2011.

Boulanger, J., K. Poole, B. Fournier, J. Wierzchowski, T. Gaines and A. Gunn. 2004. Assessment of Bathurst Caribou movements and distribution in the Slave Geological Province. Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories. Report No. 158. 120 pp.

Boulet, M., S. Couturier, S.D. Côté, R. Otto and L. Bernatchez. 2005. Gene Flow Patterns Between Migratory, Montane, and sedentary Caribou Herds of Northern Québec and Labrador: Lessons from Satellite Tracking, Microsatellite Genotyping, and Population Simulations. Ministere des Ressources naturelles et de la Faune, Direction de la recherché sur la faune, QC. 46 pp.

Boulet, M., S. Couturier, S.D. Côté, R. Otto and L. Bernatchez. 2007. Integrative use of Spatial, Genetic, and Demographic Analyses for Investigating Genetic Connectivity Between Migratory, Montaine, and Sedimentary Caribou Herds. Molecular Ecology 16: 4223-4240.

Bowles, A.E., B. Tabachnick and S. Fidell. 1991. Review of the Effects of Aircraft Overflights on Wildlife: Volume II and III: Technical Report. BBN Systems and Technologies, Canoga Park, CA.

Bowman, J.C. and J.-F. Robitaille. 1997. Winter Habitat use of American Martens *Martes americana* within Second-growth Forest in Ontario, Canada. Wildlife Biology 3: 97-105.

Bramble, W.C., R.H. Yahner and W.R. Byrnes. 1994. Nesting of Breeding Birds on an Electric Utility Line Right-of-way. Journal of Arboriculture 20(2): 124-129.

Breault, A. and J.-P. L. Savard. 1991. Status Report on the Distribution and Ecology of Harlequin Ducks in British Columbia. Canadian Wildlife Service Technical Report Series no. 110. Pacific and Yukon Region, Delta.

Brodeur, S., J.-P. L. Savard, M. Robert, A. Bourget, G. Fitzgerald and R.D. Titman. 2008. Abundance and Movements of Harlequin Ducks Breeding on Rivers of the Gaspé Peninsula, Québec. Waterbirds. 31(2): 122-129.

Brown, W.M., R.C. Drewien and E.G. Bizeau. 1987. Mortality of Cranes and Waterfowl from Powerline Collisions in the San Luis Valley, Colorado. In J.C. Lewis (ed.). Proceedings of the Crane Workshop. Grand Island, Nebraska: Platte River Whooping Crane Maintenance Trust. pp. 128–136.

Brumm, H. 2004. The Impact of Environmental Noise on Song Amplitude in a Territorial Bird. Journal of Animal Ecology. 73 (3): 434-440.

Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). In A. Poole (ed.). The Birds of North America Online. Ithaca: Cornell Lab of Ornithology; Available at: http://bna.birds.cornell.edu/bna/species/506.

Burton, P.J. 2002. Effects of Clearcut Edges on Trees in the Sub-boreal Spruce Zone of Northwest-Central British Columbia. Silva Fennica 36(1): 329–352.

Burzynski, M., T. Knight, S. Gerrow, J. Hoffman, R. Thompson, P. Deering, D. Major, S. Taylor, C. Wentzell, A. Simpson and W. Burdett. 2005. State of the Park Report, Gros Morne National Park of Canada: An Assessment of Ecological Integrity.

Cadman, M.D. and A.M. Page. 1994. Status Report on the Short-eared Owl (*Asio flammeus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, Ontario.

Cameron, R.D., D.J. Reed, J.R. Dau and W.T. Smith. 1992. Redistribution of Calving Caribou in Response to Oil Field Development on the Arctic Slope of Alaska. *Arctic* 45: 338-342.

Cameron, R.D., K.R. Whitten, W.T. Smith and D.D. Roby. 1979. Caribou Distribution and Group Composition Associated with Construction of the Trans-Alaska Pipeline. Canadian Field-Naturalist 93: 155-162.

Cassirer, E.F. and C.R. Groves. 1991. Harlequin Duck Ecology in Idaho: 1987-1990. Idaho Dept. of Fish Game, Boise, ID.

Chapin, T.G., D.J. Harrison and D.M. Phillips. 1997. Seasonal Habitat Selection by Marten in an Untrapped Forest Preserve. Journal of Wildlife Management 61: 707-717.

Chapin, T.G., D.J. Harrison and D.D. Katnik. 1998. Influence of Landscape Pattern on Habitat Use by American Marten in an Industrial Forest. Conservation Biology 12(6): 1327 – 1337.

Chen, J., J.F. Franklin and T.A. Spies. 1992. Vegetation Responses to Edge Environments in Old-Growth Douglas – Fir Forests. Ecological Applications 2(4): 387-396.

Chubbs, T.E., T.S. Jung, R.P. Otto, C. Jones and F.R. Phillips. 2001. Population Status and Distribution of Two Woodland Caribou Herds in Labrador. 9th North American Caribou Workshop, April 23-27, Kuujjuaq, Québec. Canada.

Chubbs, T.E., L.B. Keith, S.P. Mahoney and M.J. McGrath. 1993. Responses of Woodland Caribou (R*angifer tarandus caribou*) to Clear-cutting in East-central Newfoundland. Canadian Journal of Zoology 71: 487-493.

Clarkson, P. 1994. Managing Watersheds for Harlequin Ducks. American River Manage. Soc., Grand Junction, CO.

COSEWIC. 2006. COSEWIC Assessment and Status Report on the Rusty Blackbird *Euphagus carolinus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp. Available at: http://dsp-psd.pwgsc.gc.ca/Collection/CW69-14-495-2006E.pdf.

COSEWIC. 2007a. COSEWIC Assessment and Status Report on the Olive-sided Flycatcher *Contopus cooperi* in Canada. Ottawa, ON. vii + 25 pp. Available at: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_olivesided_flycatcher_0808_e.pdf.

COSEWIC. 2007b. COSEWIC Assessment and Status Report on the Red Knot *Calidris canutus* in Canada. Ottawa, vii + 58 pp. Available at: http://www.gov.ns.ca/natr/wildlife/biodiversity/pdf/statusreports/sr_RedKnotDraft.pdf.

COSEWIC. 2011. Wildlife Species Search. Available at: http://www.cosewic.gc.ca/eng/sct1/index_e.cfm. Accessed: April and August 2011.

Courtois, R., J.P. Ouellet, L. Breton, A. Gingras and C. Dussalt. 2007. Effects of Forest Disturbance on Density, Space use, and Mortality of Woodland Caribou. *Ecoscience* 14: 491-498.

Crooks, K.R. 2002. Relative Sensitivities of Mammalian Carnivores to Habitat Fragmentation. Conservation Biology Vol. 16, No. 2, April 2002, pp 488-502.

Crowley, D.W. and S.M. Patten, Jr. 1996. Breeding Ecology of Harlequin Ducks in Prince William Sound, Alaska. Exxon Valdez Oil Spill State / Federal Natural Resource Damage Assessment Final Report (Restoration Study no. 71), Alaska Dept. Fish Game. Anchorage, AK.

Cumming, H.G. and D.B. Beange. 1993. Survival of Woodland Caribou in Commercial Forests of Northern Ontario. The Forestry Chronicle 69: 579-588.

Cumming, H.G. and B.T. Hyer. 1998. Experimental Log Hauling through a Traditional Caribou Wintering Range. *Rangifer, Special Issue* No. 10: 241-258.

Cumming, J.L., P.A. Pipas, J.C. Luchsinger, J.E. Davis, M.J. Pipas and J.B. Bourassa. 2003. Managing Common Nighthawks at McConnel Air Force Base, Kansas, to reduce aircraft strikes. In K.A. Fagerstone, and C.W. Witmer (ed.). Proceedings of the 10th Wildlife damage management Conference.

Curatolo, J.A. and S.M. Murphy. 1986. The effects of pipelines, roads, and traffic on the movements of caribou, *Rangifer tarandus.* Canadian Field-Naturalist 100: 218-224.

CWS and CWF (Canadian Wildlife Service and Canadian Wildlife Federation). 1993. Mammal Fact Sheets: Red Fox. Hinterland Who's Who. Available at: http://www.hww.ca/hww2.asp?id=102. Accessed: 2011.

Dalley, K., K. Powell and D. Whitaker. 2005. The Status of Grey-cheeked Thrush (*Catharus minimus*) in Newfoundland and Labrador. Prepared for the Newfoundland and Labrador Species Status Advisory Committee. 19 pp.

Deichmann, K.H. 1990. An Assessment of Environmental Impacts Relating to Past and Present Use of Over Snow Vehicles within the Boundaries of Gros Morne National Park.

DesGranges, J.-L., J. Rodrigue, B. Tardif and M. Laperle. 1998. Mercury Accumulation and Biomagnification in Ospreys (*Pandion haliaetus*) in the James Bay and Hudson Bay regions of Québec Arch. Environ. Contam. Toxicol. Vol. 35, No. 2, pp. 330-341.

DFO (Fisheries and Oceans Canada). 2007. Newfoundland and Labrador Operational Statement, Overhead Line Construction. Available at: http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/nl/pdf/overhead_e.pdf. Accessed: May 2010.

DFO. 2009. Newfoundland and Labrador Scheduled Salmon Rivers. Available at: http://www.nfl.dfo-mpo.gc.ca/folios/00090/docs/Scheduled_Salmon_Rivers_Map-eng.pdf. Accessed: May 2010.

DND (Department of National Defence). 1994. An Environmental Impact Statement on Military Flying Activities in Labrador and Quebec.

Dreyer, G.D. and W.A. Niering. 1986. Evolution of Two Herbicide Techniques in Electric Transmission Rights-of-Way: Development of Relatively Stable Shrublands. Environmental Management 10: 113-118.

Drew, G.S. 1995. Winter Habitat Selection by American Marten (*Martes americana*) in Newfoundland; Why Old Growth? A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Wildlife Ecology, Utah State University, Logan, UT.

Dube, C., S. Pellerin and M. Poulin. 2011. Do Power Line Rights-of-Way Facilitate the Spread of Non-peatland and invasive Plants in Bogs and Fens? Botany 89: 91–103.

Dyer, S.J. 1999. Movement and Distribution of Woodland Caribou (*Rangifer tarandus caribou*) in Response to Industrial Development in Northeastern Alberta. Master's Thesis. University of Alberta.

Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2001. Avoidance of Industrial Development by Woodland Caribou. Journal of Wildlife Management 65: 531-542.

Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2002. Quantifying Barrier Effects of Roads and seismic Lines on Movements of Female Woodland Caribou in Northeastern Alberta. Canadian Journal of Zoology 80: 839-845.

Dyke, C. 2010. Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division, Corner Brook, NL. Meeting. November 3, 2010.

Easton, W.E. and K. Martin. 1998. The Effect of Vegetation Management on Breeding Bird Communities in British Columbia. Ecological Applications 8:1092–1103. [doi:10.1890/1051-0761(1998)008[1092:TEOVMO]2.0.CO;2]

Environment Canada. 2006. Recovery Strategy for the Red Crossbill, *percna* subspecies (*Loxia curvirostra percna*), in Canada (Proposed). *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, ON. vii + 29 pp.

Environment Canada. 2007a. Environment Canada Background Document on the Management of Incidental Take of Migratory Birds: Towards an Updated Regulatory Approach. (25 October) Ottawa, ON.

Environment Canada. 2007b. Management Plan for the Harlequin Duck (*Histrionicus histrionicus*) Eastern Population, in Atlantic Canada and Québec. Species at Risk Act Management Plan Series. Environment Canada. Ottawa. vii + 32 pp.

Environment Canada. 2009. Species at Risk Public Registry. Available at: http://www.sararegistry.gc.ca. Accessed: 2009.

Environment Canada. 2010a. Management Plan for the Boreal Felt Lichen – Boreal Population (*Erioderma pendicellatum*) in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. 4 pp. + Appendix.

Environment Canada. 2010b. Species at Risk Registry. Available at: http://www.sararegistry.gc.ca. Accessed: March 2011.

Environment Canada. 2011a. Management Plan for Fernald's Milk-vetch (*Astragalus robbinsii* var. *fernaldii*) in Canada. Species at Risk Public Registry. Available at: http://www.sararegistry.gc.ca/species/speciesdetails. Accessed: March 2011.

Environment Canada. 2011b. Recovery Strategy for the Woodland Caribou, Boreal population (*Rangifer tarandus caribou*) in Canada (Proposed). *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. vi + 55 pp.

Erickson, W.P., G.D. Johnson and D.P. Young Jr. 2005. A summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. USDA Forest Service General Technical Report PSW-GTR-191:1029-1042.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young Jr., K.J. Sernka and R.E. Good. 2001. Avian Collision with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States. National Wind Coordinating Committee (NWCC) Resource Document.

Farmer, A.M. 1993. The Effects of Dust on Vegetation – A Review. Environmental Pollution 79:63-75.

Fillier, D., C. Lundrigan and K. Knox. 1995. Western Newfoundland Model Forest Pine Marten Habitat Utilization Study, 1993-1995.

FILT (Forest Invasives Leadership Team). 2009. Invasive Species Best Management Practices (BMPs) for the Transportation and Utility Rights-of-Ways in Wisconsin. Report prepared for the Wisconsin Council on Forestry.

Folinsbee, J.D., R.D. Riewe, W.O. Pruitt, Jr. and P.R Grant. 1973. Ecological Distribution of the Meadow Vole, *Microtus pennsylvanicus terraenovae*, (Rodentia: Cricetidae), on the Main Island of Newfoundland. Canadian Field-Naturalist 87: 1-4.

Forsey, S.E. and E.M. Baggs. 2001. Winter Activity of Mammals in Riparian Zones and Adjacent Forests Prior to and Following Clear-cutting at Copper Lake, Newfoundland, Canada. Forest Ecology and Management 145:163-171.

Fortin, D., R. Courtois, P. Etcheverry, C. Dussault and A. Gingras. 2008. Winter selection of landscapes by woodland caribou: behavioural response to geographical gradients in habitat attributes. Journal of Applied Ecology 45: 1392-1400.

Fortin, C., V. Banci, J. Brazil, M. Crête, J. Huot, M. Huot, R. Lafond, P. Paré, J. Shaefer and D. Vandal. 2005. National Recovery Plan for the Wolverine (*Gulo gulo*) (Eastern Population). National Recovery Plan No. 26. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario. 33 pp.

Frederickson, R.J. 1990. The Effects of Disease, Prey Fluctuation, and Clear-cutting on American Marten in Newfoundland, Canada. M.Sc. Thesis, Utah State University, 84pp.

Fuller, A.K. and D.J. Harrison. 2005. Influence of Partial Timber Harvesting on American Martens in North-central Maine. Journal of Wildlife Management 69: 710-722.

Garcia, E. and R. Carignan. 2000. Mercury Concentrations in Northern Pike (*Esox lucius*) from Boreal Lakes with Logged, Burned, or Undisturbed Catchments. Can. J. Fish. Aquat. Sci. 57:129-135.

Garland, S. and P. Thomas. 2009. Recovery Plan for Red Knot, Rufa Subspecies (*Calidris canutus rufa*), in Newfoundland and Labrador. Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL. iv + 12 pp.

Gerrard, P.M. and V.L. St. Louis. 2001. The Effects of experimental Reservoir Creation on the Bioaccumulation of Methylmercury and reproductive Success of Tree Swallows (*Tachycineta bicolor*). Environ. Sci. & Technol. 35:1329-1338.

Gerrow, J.S. 2002. Distribution and Abundance of the American Marten (*Martes americana*) in the Greater Gros Morne Ecosystem: Final Report (2001-2002). Report prepared for Gros Morne National Park of Canada.

Gilliland, S.G., G.J. Robertson and G.S. Goodyear. 2008a. Distribution and Abundance of Harlequin Ducks Breeding in Northern Newfoundland. Waterbirds 31 (Special Publication 2): 104-109.

GNL. 2002. Water Resources Act, SNL 2002 cW-4.01. Available at: http://assembly.nl.ca/Legislation/sr/statutes/w04-01.htm. Accessed: October 2010.

GNL. 2005. Provincial Sustainable Forest Management Strategy. Department of Natural Resources, Forest Resources Branch, St. John's, NL.

GNL. 2011. Department of Environment and Conservation. Wildlife – All Species. Available at: http://www.env.gov.nl.ca/env/wildlife/all_species/index.html. Accessed: March and August 2011.

Godbout, G. and J.-P. Ouellet. 2008. Habitat Selection of American Marten in a Logged Landscape at the Southern Fringe of the Boreal Forest. Ecoscience 15(3):332-342.

Gollop, M.A., J.E. Black, B.E. Fleske and R.A. Davis. 1974. Disturbance Studies of Breeding Black Brant, Common Eiders, Glaucous Gulls and Arctic Terns at Nunaluk Spit and Phillips Bay, Yukon Territory, July 1972. In w.w. Gunn and J.A. Livingston (ed.). Disturbance to Birds by Gas Compressor Noise Simulators, Aircraft and Human Activity in the MacKenzie Valley and the North Slope, 1972. Arctic Gas Biol. Rep. Ser. 14 (4):153-201.

Gosse, J.W., R. Cox and S.W. Avery. 2005. Home-range Characteristics and Habitat use by American Martens in Eastern Newfoundland. Journal of Mammalogy 86: 1156-1163.

Gosse, J.W. and W.A. Montevecchi. 2001. Relative Abundances of Forest Birds of Prey in western Newfoundland. Canadian Field-Naturalist 115(1): 57-63.

Gosse, M.M., A.S. Power, D.E. Hyslop and S.L. Pierce. 1998. Guidelines for Protection of Freshwater Fish Habitat in Newfoundland and Labrador. Fisheries and Oceans, St. John's, NF.

Goudie, R.I. and S.G. Gilliland. 2008. Aspects of Distribution and Ecology of Harlequin Ducks on the Torrent River, Newfoundland. Waterbirds 31 (Special Publication 2): 92-103.

Goudie, R.I. and I.L. Jones. 2004. Dose-response Relationships of Harlequin Duck Behaviour to Noise from Low Level Military Jet Over-flights in Central Labrador. Environmental Conservation 31(4): 1-10.

Goudie, R.I. and W.R. Whitman. 1987. Waterfowl Populations in Labrador, 1980-82. In A. J. Erskine (ed.). Waterfowl Breeding Population Surveys, Atlantic Provinces. Canadian Wildlife Service Occasional Paper No. 60. pp. 45-60.

Government of Canada. 1991. Federal Policy on Wetland Conservation. Environment Canada, Ottawa, ON.

Government of Canada. 2011. Invasive Species in Canada. Available at: http://75.103.127.138/english/View.asp?x=501. Accessed: 2011.

Government of Newfoundland and Labrador and the Government of Canada. 2011. Environmental Impact Statement Draft Guidelines and Scoping Document - Labrador-Island Transmission Link. Prepared for Nalcor Energy. St. John's, NL.

Graham, K.L. 2002. Human Influences on Forest Wildlife Habitat. In D.N. Wear and J.G. Greis (ed.). Southern forest resource assessment. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 pp.

Grigal, D.F. 1985. Impact of Right-of-Way Construction on Vegetation in the Red Lake Peatland, Northern Minnesota. Journal of Environmental Management 9: 449-454.

Gross, D.A. 1994. Discovery of a Blackpoll Warbler (*Dendroica striata*) nest, a first for Pennsylvania - Wyoming County. Pennsylvania Birds 8:128-132.

Hanel, C. 2011. Ecosystem Management Biologist, Newfoundland and Labrador Department of Environment and Conservation - Wildlife Division. Personal Communication (email). February 2011.

Hansen, A., J. Garman, S. Lee, P. and E. Horvath. 1993. Do Edge Effects Influence Tree Growth Rates in Douglas Fir Plantations? Northwest Science. 67: 112-116.

Hansena, M.J. and A.P. Clevenger. 2005. The Influence of Disturbance and Habitat on the Presence of Non-Native Plant Species Along Transport Corridors. Biological Conservation 125 (2): 249-259.

Hanson, A., L. Swanson, D. Ewing, G. Grabas, S. Meyer, L. Ross, M. Watmough and J. Kirkby. 2008. Wetland Ecological Functions Assessment: An Overview of Approaches. Canadian Wildlife Service. Atlantic Region. Technical Report Series No 497.

Hargis, C.D., J.A. Bissonette and D.L. Turner. 1999. The Influence of Forest Fragmentation and Landscape Pattern on American Martens. Journal of Applied Ecology 36: 157-172.

Harrington, F.H. and A.M. Veitch. 1991. Short-term Impacts of Low-level Jet Fighter Training on Caribou in Labrador. *Arctic* 44(4): 318-327.

Harrington, F.H. and A.M. Veitch. 1992. Calving Success of Woodland Caribou Exposed to Low Level Jet Fighter Overflights. *Arctic* 45(3): 213-218.

Harron, D. 2003. Potential Effects of Transmission Lines and Other Linear Developments on Wildlife in Manitoba. May 2003 Working Draft.

Hearn, B.J., D.J. Harrison, A.K. Fuller, C. Lundrigan and W.J. Curran. 2010. Paradigm Shifts in Habitat Ecology of Threatened Newfoundland Martens. Journal of Wildlife Management 74(4): 719-728.

Hearn, B.J. 2005. Newfoundland Marten: Developing Conservation Guidelines for a Species at Risk. Available at: http://cfs.nrcan.gc.ca/news/327. Accessed: June 5, 2010.

Hirvonen H. 2001. Impacts of Highway Construction and Traffic on a Wetland Bird Community. In C.L. Irwin, P. Garrett and K.P. McDermott (ed.). Proceedings of the 2001 International Conference on Ecology and Transportation. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC. pp. 369-372.

Holzapfel, C. and W. Schmidt. 1990. Roadside Vegetation Along Transects in the Judean Desert. Israel Journal of Botany 39: 263-270.

Howes, L. 1993. Pine Marten Distribution Study. Western Newfoundland Model Forest. Report Number 2-201-001.

Hunt, W.A. 1998. The Ecology of Harlequin Ducks (*Histrionicus histrionicus*) Breeding in Jasper National Park, Canada. Master's Thesis, Simon Fraser University, Burnaby, BC.

Hunt, P.D. and B.C. Eliason. 1999. Blackpoll Warbler (*Dendroica striata*). In A. Poole (ed.). The Birds of North America Online, Cornell Lab of Ornithology, Ithaca. Retrieved from the Birds of North America Available at: http://bna.birds.cornell.edu/bna/species/431.

IBA 2012. Important Bird Areas in Canada: Site Summary. Accessed on-line February 2012 http://www.bsc-eoc.org/iba/site.jsp?siteID=NF018

Ilhardt, B.L., E.S. Verry and B.J. Palik. 2000. Defining Riparian Areas. In R.G. Wagner and J.M. Hagan (ed.). Forestry and the Riparian Zone - Conference Proceedings. October 26, 2000. University of Maine. Orono, Maine, U.S.A.

Iron, J. and R. Pittaway. 2000. Urban crows and nighthawks. Ontario Field Ornithologists News 18: 13.

Jacques Whitford. 1995. 1994 Avoidance Monitoring Program, Raptor/Harlequin Duck. Report prepared for PMO Goose Bay, National Defence Headquarters, Ottawa, ON. 60 pp. + Appendices.

Jacques Whitford. 1997. Distribution of Wintering Moose within the Low-Level Training Area of Labrador and Northeastern Quebec, 1997. Jacques Whitford Environment report prepared for PMO Goose Bay, National Defence Headquarters, Ottawa, ON.

Jacques Whitford. 1998. 1997 Osprey Monitoring Program. Environmental Mitigation Program supporting Military Flying Activity in Goose Bay, Labrador. Jacques Whitford Environment report prepared for Goose Bay Office, National Defence Headquarters, Ottawa, ON.

Jacques Whitford. 1999. Osprey and Bald Eagle Study. Prepared for the Churchill River Power Project. 1998 Environmental Studies, LPH 98-11. Newfoundland and Labrador Hydro. St. John's, NL. 30 pp. + Appendices.

James, A.R.C. 1999. Effects of industrial development on the predator-prey relationship between wolves and caribou in northeastern Alberta. Ph. D. Thesis, University of Alberta, Edmonton, AB.

James, A.R.C., S. Boutin, D.M. Hebert and A.B. Rippin. 2004. Spatial separation of caribou from moose and its relation to predation by wolves. Journal of Wildlife Management 68: 799-809.

James, A.R. and K. Stuart-Smith. 2000. Distribution of Caribou and Wolves in Relation to Linear Corridors. Journal of Wildlife Management 64: 154-159.

Keeping, B. and C. Hanel. 2006. A 5 Year (2006 – 2011) Management Plan for the Boreal Felt Lichen (*Erioderma pedicellatum*) In Newfoundland and Labrador. Prepared in conjunction with the Boreal Felt Lichen Working Group, for the Wildlife Division, Newfoundland and Labrador Department of Environment and Conservation.

Koeth, T. and E. Vauk-Hentzelt. 1988. Influence of Plumage and Stomach Oiling on Body and Organ Growth in Young Kittiwakes, Mar. Poll. Bull. 19:71-73.

Krochko, N. 2005. Bird Collisions with Electric Power Transmission Lines: Frequently Asked Questions (FAQs). AltaLink. Available at: http://www.stalbert.ca/uploads/files/our_government/city_council/City%20Council%20Agenda%202008/October%2020/10-Att1AltaLinkTransmissionLineRelocation.pdf.

Kuchel, C.R. 1977. Some Aspects of the Behaviour and Ecology of Harlequin Ducks Breeding in Glacier National Park, Montana. M.Sc. thesis, University of Montana, Missoula.

Kurki, S.A. Nikula, P. Helle and H. Linden. 1998. Abundances of Red Fox and Pine Marten in Relation to the Composition of Boreal Forest Landscapes. J. Animal Ecology 1998, 67, 784-886.

LaPierre, L. 2008. Chair, Institute for Environmental Monitoring and Research. Happy Valley-Goose Bay, NL. Written communication.

Latham, A.D.M., M.C. Latham, N.A. McCutchen and S. Boutin. 2011. Invading White-tailed Deer Change Wolf-caribou Dynamics in Northeastern Alberta. Journal of Wildlife Management 75(1): 204-212.

LBHSP (Limestone Barrens Habitat Stewardship Program). 2010. Limestone Barrens: Ours to Protect. Available at: http://www.limestonebarrens.ca/Background.htm. Accessed: May 2010.

Levenson, H. and J.R. Koplin. 1984. Effects of Human Activity on Productivity of Nesting Ospreys. Journal of Wildlife Management 48: 1,374-1,377.

Lewis, K.P., Weir, J.N., G. Luther, S. Mahoney, S. Morrison, H. Rangell, and C.E. Soulliere. 2011. Woodland Caribou Population Monitoring in Newfoundland: Resolving Population Surveys, Population Models, and Demographic Metrics. Poster presentation at: Challenges of Managing Northern Ungulates, The 13th International Arctic Ungulate Conference, August 22-26, 2011. Yellowknife, Northwest Territories.

LGL Limited. 2008. Waterfowl in the Lower Churchill River Area. Report prepared for Minaskuat Inc. and Newfoundland and Labrador Hydro, Lower Churchill Hydroelectric Generation Project, St. John's, NL.

Lock, A.R., R.G.B. Brown and S. Gerriets. 1994. Gazetteer of Marine Birds in Atlantic Canada: An atlas of seabird vulnerability to oil pollution. Canadian Wildlife Service, Environmental Conservation Branch, Environment Canada, Atlantic Region. Dartmouth, NS.

Loos, G. and P. Kerlinger. 1993. Road mortality of Saw-whet and Screech-owls on the Cape May peninsula. Journal of Raptor Research 27(4): 210-213.

Lowther, P.E., C.C. Rimmer, B. Kessel, S.L. Johnson and W.G. Ellison. 2001. Gray-cheeked Thrush (*Catharus minimus*). In A. Poole (ed.). The Birds of North America Online, Cornell Lab of Ornithology, Ithaca, NY. Available at: http://bna.birds.cornell.edu/bna/species/591.

Lundrigan, C. and D. Fillier. 1995. Pine Marten Baseline Component 1995 Annual Report Draft. Western Newfoundland Model Forest. Report Number 2-201-007.

Mack, D.E. and W. Yong. 2000. Swainson's Thrush (*Catharus ustulatus*). In A. Poole (ed.). The Birds of North America Online. Cornell Lab of Ornithology; Ithaca, NY. Available at: http://bna.birds.cornell.edu/bna/species/540.

MacLellan, P. and J.M. Stewart. 1986. Latitudinal Gradients in Vegetation along a Disturbed Transmission Line Right-of-Way in Manitoba. Canadian Journal of Botany. 64: 1311-1320.

Magnusson, B. and J. Stewart. 1987. Effects of Disturbances along Hydroelectrical Transmission Corridors through Peatlands in Northern Manitoba, Canada. Arctic and Alpine Research. 19(4): 470-478.

Mahoney, S.P. and J.A. Schaefer. 2002. Hydroelectric Development and the Disruption of Migration in Caribou. Biological Conservation 107: 147-153.

Mahoney, S.P. and J.A. Virgil. 2003. Habitat Selection and Demography of a Nonmigratory Woodland Caribou Population in Newfoundland. Canadian Journal of Zoology 81: 321-334.

Maier, J.A., S.M. Murphy, R.G. White and M.D. Smith. 1998. Responses of Caribou to Overflights by Low-altitude Jet Aircraft. Journal of Wildlife Management 62: 752-766.

Manci, K.M., D.N. Gladwin, R. Villella and M.G. Cavendish. 1988. Effects of Aircraft Noise and Sonic Booms on Wildlife: A Literature Synthes. USFWS National Ecology Research Centre. Ft. Collins, CO. NERC-88/29.

Manville, A.M. 2005. Bird Strikes and Electrocutions at Power Lines, Communication Towers, and Wind Turbines: State of the Art and State of the Science -Next Steps Towards Mitigation. USDA Forest Service Gen Tech Rep PSW-GTR-191.

Marshall, I.B. and P.H. Schutt. 1999. Ecosystems Science Directorate, Environment Canada, and A National Ecological Framework for Canada - Overview. Research Branch, Agriculture and Agri-Foods Canada.

Marshall, J.S. and L.W. Vandruff. 2002. Impact of Selective Herbicide Right-of-Way Vegetation Treatment on Birds. Environmental Management Vol. 30, No. 6, pp. 801–806.

McCarthy, S.C., R.B. Weladji, C. Doucet and P. Saunders. 2011. Woodland Caribou Calf Recruitment in Relation to Calving/Post-calving Landscape Composition. Rangifer 31(1): 35-47.

Meades, S. 2011. Field Biologist / Scientific Authority (Rare Plants). NLDEC (Wildlife Division) Personal Communication. February 2011.

Mercer, E., S. Mahoney, K. Curnew and C. Finlay. 1985. Distribution and Abundance of Insular Newfoundland Caribou and the Effects of Human Activities. In T.C. Meredith and A.M. Martell (ed.). Proceedings of Second North American Caribou Workshop. McGill Subarctic Research Paper No. 40, Montreal, Quebec, Canada. p. 16-32.

Minaskuat Inc. 2008a. Wildlife Habitat Associations in the Lower Churchill River. Prepared for the Lower Churchill Hydroelectric Generation Project. St. John’s, NL.

Minaskuat Inc. 2008b. Project Area Ecological Land Classification. Prepared for the Lower Churchill Hydroelectric Generation Project. St. John’s, NL.

Minaskuat Inc. 2008c. Forest Songbird Surveys. Prepared for the Lower Churchill Hydroelectric Generation Project. St. John’s, NL.

Minaskuat Limited Partnership. 2003a. 2003 Osprey Monitoring Program in the Low-Level Training Area of Labrador. Report prepared for the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL, 9 pp + Appendices.

Minaskuat Limited Partnership. 2003b. Nesting behaviour of Gray Jays (*Perisoreus canadensis*) during Military Aircraft Noise Events. Report prepared for the Institute for Environmental Monitoring and Research. Happy Valley - Goose Bay, NL. 20 pp + Appendices.

Minaskuat Limited Partnership. 2004. Jet Aircraft Effects on Nesting Canada Geese (*Branta canadensis*). Report prepared for the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL. 19 pp + Appendices.

Minaskuat Limited Partnership. 2005a. Jet, Rotary and Fixed-wing Propeller Driven Aircraft Effects on Nesting Canada Geese (*Branta canadensis*). Report prepared for the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL. 55 pp.

Minaskuat Limited Partnership. 2005b. Bald Eagle Nest Reconnaissance, Final Report # MIN0115.

Minaskuat Limited Partnership. 2005c. Response of Moulting Black Ducks to Jet Aircraft Activity – Preliminary Investigation. Report prepared for the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL.

Minaskuat Limited Partnership. 2007. Field Testing of NestMonitors™ – Canada Goose (*Branta canadensis*) Component. Report prepared for the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL. 38 pp. + Appendices.

Mitchell, G.W., I.G. Warkentin and P.D. Taylor. 2009. Movement of Juvenile Songbirds in Harvested Boreal Forest: Assessing Residency Time and Landscape Connectivity. Avian Conservation and Ecology - Écologie et conservation des oiseaux 4(1): 5. Available at: http://www.ace-eco.org/vol4/iss1/art5/.

Morgan, K. and C. Doucet. 2007. Forest Management Guidelines for Woodland Caribou (*Rangifer tarandus caribou*) for the Island of Newfoundland. Government of Newfoundland and Labrador, Department of Environment and Conservation, Wildlife Division, Corner Brook, NL.

Mowat, G. and B. Slough. 2003. Habitat preference of Canada Lynx through a Cycle in Snowshoe Hare Abundance. Can. J. Zool. Vol 18 2003. pp 1736-1745.

Mowbray, T.B. 1997. Swamp Sparrow (*Melospiza georgiana*). In A. Poole and F. Gill (ed.). The Birds of North America, No. 279, The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, DC.

Mowbray, T.B., C.R. Ely, J.S. Sedinger and R.E. Trost. 2002. Canada Goose (*Branta canadensis*). In A. Poole, P. Stettenheim and F. Gill (ed.). The Birds of North America, No. 682. The American Ornithologists' Union. Washington, DC, The Academy of Natural Sciences. Philadelphia, PA.

Nalcor (Nalcor Energy). 2009. Lower Churchill Hydroelectric Generation Project Environmental Impact Statement. Nalcor Energy, St. John's, NL.

Nellemann, C. and R.D. Cameron. 1998. Cumulative impacts of an Evolving Oil-field Complex on the Distribution of Calving Caribou. Canadian Journal of Zoology 76: 1425-1430.

Nellemann, C., I. Vistnes, P. Jordhøy and O. Strand. 2001. Winter Distribution of Wild Reindeer in Relation to Power Lines, Roads and Resorts. Biological Conservation 101: 351-360.

Nellemann, C., I. Vistnes, P. Jordhøy, O. Strand and A. Newton. 2003. Progressive Impact of Piecemeal Infrastructure Development on Wild Reindeer. Biological Conservation 113: 307-317.

Newfoundland and Labrador Forestry Act. 1990. Available at: http://www.assembly.nl.ca/Legislation/sr/statutes/f23.htm.

Newfoundland and Labrador Hydro. 2008. Environmental Performance Report. Available at: http://www.nlh.nl.ca/enviro2008/print.html. Accessed: September 2010.

Newfoundland and Labrador Refining Corporation. 2007. Newfoundland and Labrador Refinery Project EIS and Comprehensive Study. St. John's, NL.

Nickerson, N.H., R.A. Dobberteen and N.M. Jarman. 1989. Effects of Power-Line Construction on Wetland Vegetation in Massachusetts, USA. Environmental Management. 13: 477-483.

NLDE (Newfoundland and Labrador Department of Education). 2009. Toward a Sustainable Future - Challenges, Changes, Choices.

NLDEC (Newfoundland and Labrador Department of Environment and Conservation). 1999. Policy for Land and Water Related Developments in Protected Public Water Supply Areas. Available at: http://www.env.gov.nl.ca/env/waterres/regulations/policies/water_related.html. Accessed: May 2010.

NLDEC. 2007. Hunting and Trapper Guide 2007-2008. Department of Environment and Conservation. Province of Newfoundland and Labrador.

NLDEC. 2009a. Natural Balance: Woodland Caribou. Publication prepared for Canadian Environment Week May 31-June 6, 2009. Government of Newfoundland and Labrador, St. John's, NL. Available at: http://www.env.gov.nl.ca/env/publications/wildlife/index.html. Accessed: March 24, 2011.

NLDEC. 2009b. Hunting and Trapping Guide 2009-2010. Government of Newfoundland and Labrador, St. John's, NL.

NLDEC. 2010a. GIS Data - Public Water Supplies. Available at: http://www.env.gov.nl.ca/env/waterres/gis/gis.html. Accessed: May 2010.

NLDEC. 2010b. Hunting and Trapping Guide 2010-2011. Government of Newfoundland and Labrador, St. John's, NL.

NLDEC. 2010c. Endangered Species and Biodiversity Section. Management Plan for the Gray-cheeked Thrush (*Catharus minimus*) in Newfoundland and Labrador. Corner Brook, Canada. Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division. iii + 19 pp.

NLDEC. 2011a. Species status Advisory Committee. General Status of Species. Available at: http://www.env.gov.nl.ca/env/wildlife/all_species/general_status.html. Accessed: September 2011.

NLDEC. 2011b. Hunting and Trapping Guide 2011-2012. Government of Newfoundland and Labrador, St. John's, NL.

NLDEC. 2011c. Province of Newfoundland and Labrador responses to Labrador-Island Transmission Link – Furbearers and Small Mammal Component Study. Corner Brook, NL.

NLDEC. n.d. The Coyote. Upublished data. Available at: http://www.env.gov.nl.ca/env/snp/programs/education/animal_facts/mammals/coyote.html. Accessed: March 2012.

NLDEC-W (Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division). 2010. Endangered Species and Biodiversity Section. Management Plan for the Gray-cheeked Thrush (*Catharus minimus*) in Newfoundland and Labrador. Corner Brook, Canada. iii + 19 pp.

NLDFRA (Newfoundland and Labrador Department of Forest Resources and Agrifoods). 2000. Minister announces 2000/2001 big game licence seasons and quotas. News Release, 2 March 2000. Government of Newfoundland and Labrador. St. John's, NL. Available at: http://www.releases.gov.nl.ca/releases/2000/forest/0302n03.htm. Accessed: March 26, 2011.

NLDFRA. 2003. Provincial Sustainable Forest Management Strategy. Government of Newfoundland and Labrador, Department of Forest Resources and Agrifoods, Forest Service of Newfoundland and Labrador. St. John's, NL. 81 pp.

NLDNR (Government of Newfoundland and Labrador, Department of Natural Resources). 2011. Available at: http://www.nr.gov.nl.ca/nr/forestry/manage/district.html. Accessed: April 2011.

NLRWG (Newfoundland and Labrador Riparian Working Group). 2007. Options for Managing Riparian Habitat during Forestry Operations. Western Newfoundland Model Forest, Corner Brook, NL.

Northcott, T.H. 1971. Feeding habits of beaver in Newfoundland. OIKOS, 22: 407-410.

Northcott, P.L. 1984. Movement and distribution of caribou in relation to the Upper Salmon hydroelectric development, Newfoundland. In T. C. Meredith and A. M. Martell (ed.). Second North American Caribou Workshop, Val Morin, Quebec. Centre for Northern Studies and Research, McGill University, Montreal, Quebec, pp. 69-84.

Northland Associates Limited. 1980. Reservoir and Transmission Line (Labrador) Wildlife Reconnaissance 1980. Prepared for the Lower Churchill Development Corporation.

Novak, M. 1987. Beaver. In M. Novak, J.A. Baker, M.E. Obbard and B. Malloch (ed.). Wild Furbearer Management and Conservation in North America, Ontario Trappers Association, North Bay, ON. Pp. 282-312.

NRCan (Natural Resources Canada). 2010. CanVec. Available at: http://geogratis.cgdi.gc.ca/geogratis/en/collection/5460AA9D-54CD-8349-C95E-1A4D03172FDF.html. Accessed: May 2010.

NRCan. 2011. Forest Ecosystems of Canada – Fire. Available at: http://ecosys.cfl.scf.rncan.gc.ca/perturbation-disturbance/feu-fire-eng.asp. Accessed: July 2011.

NRG (Natural Resource Group). 2008. Palomar Gas Transmission Project: Preliminary OHV Blocking Plan. Palomar Gas Transmission Project. Resource Report 8.

NSPLC (Nova Scotia Public Lands Coalition). 2006. Issues: ATVs & ORVs. Available at: http://www.publicland.ca/issues/atvsandorvs.html. Accessed: May 2010.

NWWG (National Wetlands Working Group). 1997. The Canadian Wetland Classification System. B.G. Warner and C.D.A. Rubec (ed.). Published by Wetlands Research Centre, University of Waterloo, ON. 68 pp.

Oxley, D. J., M. B. Fenton, and G. R. Carmody. 1974. The effects of roads on populations of small mammals. The Journal of Applied Ecology. Vol 11, No. 1 (Apr 1974), pp. 51-59.

Patricelli, G.L. and J.L. Blickley. 2006. Avian Communication in Urban Noise: Causes and Consequences of Vocal Adjustment. The Auk 123(3): 639-649.

Payne, N.F. 1982. Colony Size, Age and Sex Structure of Newfoundland Beaver. Journal of Wildlife Management 43: 655-661.

Piatt, J.F., R.D. Elliot and A. MacCharles. 1985. Marine Birds and Oil Pollution in Newfoundland, 1951-1984. Newfoundland Institute for Cold Ocean Sciences Report, No 105.

Platt, C. 2002. Raptor vs. Lethal Lines. Express News. University of Alberta. Available at: http://www.expressnews.ualberta.ca/article.cfm?id=3695. Accessed: March 24, 2005.

Poole, A.F. 1989. Ospreys - A Natural and Unnatural History. Cambridge University Press, New York, NY. 246 pp.

Poole, K.G., A.D. Porter, A. de Vires, C. Maundrell, S.G. Grindale and C.C. St. Clair. 2004. Suitability of young deciduous-dominated forest for American marten and the effects of forest removal. Canadian Journal of Zoology 82: 423-435.

Potvin, F., L. Belanger and K. Lowell. 2000. Marten Habitat Selection in a Clear-Cut Boreal Landscape. Conservation Biology 14: 844-857.

Poulin, R.G., S.D. Grindal and R.M. Brigham. 1996. Common Nighthawk (*Chordeiles minor*). In A. Poole (ed.). The Birds of North America Online, Cornell Lab of Ornithology, Ithaca, NY. Available at: http://bna.birds.cornell.edu/bna/species/213.

Public Service Commission of Wisconsin 2009. Environmental Impacts of Transmission Lines. Internal Report, 16pp.

Reimers, E., K. Flydal and R. Stenseth. 2000. High Voltage Transmission Lines and Their Effect on Reindeer: A Research Programme in Progress. Polar Research 19(1): 75-82.

Rheindt, F.E. 2003. The Impact of Roads on Birds: Does Song Frequency Play a Role in Determining Susceptibility to Noise Pollution? Journal für ornithology 144: 295-306.

Richardson, C.T. and C.K. Miller. 1997. Recommendations for Protecting Raptors from Human Disturbance: A Review. Wildlife Society Bulletin 25(3): 634-638.

Robertson, G. J. and R. I. Goudie. 1999. Harlequin Duck (*Histrionicus histrionicus*). In A. Poole and F. Gill (ed.). The Birds of North America, No. 466, The Birds of North America Inc., Philadelphia, PA.

Robertson, B.A. and R.L. Hutto. 2007. Is Selectively Harvested Forest an Ecological Trap for Olive-sided Flycatchers. Condor 109:109-121.

Rodriques, B. 2010. Newfoundland and Labrador Small Mammal Monitoring Network 2009 Season Report. Prepared for Newfoundland and Labrador Department of Environment and Conservation. Corner Brook, NL.

Rodway, M.S., J.W. Gosse, I. Fong and W.A. Montevecchi. 1998. Discovery of a Harlequin Duck Nest in Eastern North America. Wilson Bulletin 110: 282-285.

Ruddock, M. and D.P. Whitfield. 2007. A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd. to Scottish Natural Heritage, UK.

Rusch, D.H., S. DeStefano, M.C. Reynolds and D. Lauten. 2000. Ruffed Grouse (*Bonasa umbellus*). In A. Poole and F. Gill (ed.). The Birds of North America, No. 515, The Birds of North America, Inc., Philadelphia, PA.

Russell, J. and D. Fifield 2001. Marine Bird Important Bird Areas near the Strait of Belle Isle and Northern Peninsula: Conservation Concerns and Potential Strategies. Can. Nature Federation, Bird Studies Canada, Natural History Society of Newfoundland and Labrador, 140 pp.

Russell, D.E., G. Kofinas and B. Griffith. 2002. Barren–Ground Caribou Calving Ground Workshop: Report of Proceedings. Technical Report Series No. 390. Canadian Wildlife Service, Ottawa, Ontario, 39pp.

Russo Garrido, S. and J. Stanley. 2002. Labrador Road Study: Local Knowledge on the Social and Environmental Impacts of the Newly Constructed Trans-Labrador Highway in South-eastern Labrador. Coasts Under Stress. Cited in: Department of Education, Province of Newfoundland and Labrador. 2009. Toward a Sustainable Future - Challenges, Changes, Choices.

SARA (Species at Risk Act). 2011. Species at Risk Public Registry. Available at: http://www.sararegistry.gc.ca/default_e.cfm. Accessed: March and October 2011.

Sargeant, A.B. 1981. Road Casualties of Prairie Nesting Ducks. Wildlife Society Bulletin 9: 65-69.

Saunders, P. 2010. Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division, Corner Brook, NL. Meeting. November 3, 2010.

Savard, J.-P. L. 1988. A Summary of Current Knowledge on the Distribution and Abundance of Moulting Sea Ducks in the Coastal Waters of British Columbia. Can. Wildl. Serv. Tech. Rep. Ser. No. 45, Pacific and Yukon Region, Delta.

Savard, J.-P. L., D. Bordage and A. Reed. 1998. Surf scoter (*Melanitta perspicillata*). In A. Poole and F. Gill (ed.). The Birds of North America, No. 363, The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, DC.

Savard, J-P. L. and P. Lamothe. 1991. Distribution, Abundance, and Aspects of Breeding Ecology of Black Scoters, *Melanitta nigra*, and Surf Scoters, *Melanitta perspicillata*, in northern Quebec. Canadian Field Naturalist 105: 488-496.

Savignac, C. 2007. COSEWIC Assessment and Status Report on the Common Nighthawk Chordeiles Minor. Report prepared for the Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp. Available at: http://www.gov.ns.ca/natr/wildlife/biodiversity/pdf/statusreports/sr_CommonNighthawk.pdf.

Schaefer, J.A. and S.P. Mahoney. 2007. Effects of Progressive Clearcut Logging on Newfoundland Caribou Journal of Wildlife Management 71: 1753-1757.

Schaefer, J.A., C.M. Bergman and S.N. Luttich. 2000. Site Fidelity of Female Caribou at Multiple Spatial Scales. Landscape Ecology 15: 731-739.

Schaefer, J.A., A.M. Veitch, F.H. Harrington, W.K. Brown, J.B. Theberge and S.N. Luttich. 1999. Demography of decline of the Red Wine Mountains caribou herd. Journal of Wildlife Management 63: 580-587.

Schmelzer, I. 2005. A Management Plan for the Short-eared Owl (*Asio flammeus flammeus*) in Newfoundland and Labrador. Wildlife Divison, Department of Environment and Conservation. Corner Brook, NL.

Schmelzer, I. 2008. A Population Estimate for Newfoundland Marten, MS Powerpoint presentation. Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division.

Schmelzer, I. 2010. Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division, Corner Brook, NL. Meeting. November 3, 2010.

Schmelzer, I., J. Brazil, T. Chubbs, S. French, B. Hearn, R. Jeffery, L. LeDrew, H. Martin, A. McNeill, R. Nuna, R. Otto, F. Phillips, G. Mitchell, G. Pittman, N. Simon and G. Yetman. 2004. Recovery strategy for three Woodland caribou herds (*Rangifer tarandus caribou*; Boreal population) in Labrador. Newfoundland and Labrador Department of Environment and Conservation, Corner Brook, NL.

Schmelzer, I. and J. Fenske. n.d. Life at the Limit: An Intraspecific Analysis of Home Range Variation for a Wide-Ranging Rodent, the North American porcupine (*Erethizon dorsatum*) in Central Labrador, Canada. Unpublished.

Schneider, R.R. and P. Yodzis. n.d. Running Head: Extinction Dynamics in the American Marten (*Martes americana*). Western Newfoundland Model Forest. Report Number 2-209-001.

Schulz, C.A., Leslie, D.M., Lochmiller, R.L. and D.M. Engle. 1992. Autumn and Winter Bird Populations in Herbicide Treated Cross-timbers in Oklahoma. The American Midland Naturalist. Vol 127, No 2, pp 215-223.

Seip, D.R. 1992. Factors Limiting Woodland Caribou Populations and Their Interrelationships with Wolves and Moose in Southeastern British Columbia. Canadian Journal of Zoology 70: 1494-1503.

Seip, D., C. Johnson and G. Watts. 2005. Displacement of Mountain Caribou from Winter Habitat by Snowmobiles. Journal of Wildlife Management 71: 1539-1544.

Sheffield, S.R. 1997. Owls as Biomonitors Of Environmental Contamination. In J. R. Duncan, D. H. Johnson, and T.H. Nicholls (ed.) Biology and Conservation of Owls in the Northern Hemisphere: 2nd International Symposium. USDA, Forest Service General. Technical Report NC—190, North Central Forest Experimental Station. p. 383-398.

Simard, J.R. and J.M. Frxyell. 2003. Effects of Selective Logging on Terrestrial Small Mammals and Arthropods. Canadian Journal of Zoology 81: 1318-1326.

Simon, N.P.P., F.E. Schwab, M.I. LeCoure and F.R. Phillips. 1999a. Fall and Winter Diet of Martens, *Martes americana*, in Central Labrador related to Small Mammal Densities. Canadian Field-Naturalist 113: 678-680.

Simon, N.P.P., F.E. Schwab, M.I. LeCoure, F.R. Phillips and P.G. Trimper. 1999b. Effects of Trapper Access on Marten Populations in Central Labrador. Northeast Wildlife 54:73-76.

Simon, N.P.P., C.B. Stratton, G.J. Forbes and F.E. Schwab. 2002. Similarity of Small Mammal Abundance in Post-fire and Clearcut Forests. Forest Ecology and Management 165 (2002) 163-172.

Skinner, W.R. 1995. The use of Pre-commercially Thinned Stands by Snowshoe Hare in the Western Newfoundland Model Forest.

Sklepkovych, B.O. and W.A. Montevecchi. 1996. Food Availability and Food Hoarding Behaviour by Red and Arctic foxes. Arctic 49(3): 228-234.

Smith, B. and D. Prichard. 1992. Riparian Area Management. US Department of the Interior. Bureau of Land Management. Technical Reference 1737-6.

Snyder, J.E. and J.A. Bissonette. 1987. Marten Use of Clearcuttings and Residual Forest Stands in Western Newfoundland. Can. J. Zool. 65: 169-174.

Soulliere, C.E., J.N. Weir, K.D. Morgan and S.P. Mahoney. 2010. Caribou Reactions to Human Infrastructure and Activity in Newfoundland, Canada: Potential Cumulative Effects. Poster, Government of Newfoundland and Labrador, Department of Environment and Conservation, Sustainable Development and Strategic Science Division. St. John's, NL. Available at: http://posters.f1000.com/Image?posterID=288&type=poster. Accessed: February 25, 2010.

SSAC (Species Status Advisory Committee). 2008. Report No.19 – The Status of Graceful Felt Lichen (*Erioderma mollissimum*) in Newfoundland and Labrador. Newfoundland and Labrador Department of Environment and Conservation.

SSAC. 2011. Species Status Advisory Committee. Available at: http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/ssac/index.html. Accessed: August 2011.

Stantec (Stantec Consulting Ltd.). 2010a. Regionally Uncommon Plant Potential Mapping. Labrador – Island Transmission Link. Final Report. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2010b. Ecological Land Classification. Labrador – Island Transmission Link. Final Report. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2010c. Wetlands Inventory and Classification. Labrador – Island Transmission Link. Final Report. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2010d. 2010 Plant Survey in the Vicinity of the Lower Churchill River Watershed. Final Report. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2010e. Furbearer and Small Mammal Component Study for the Labrador-Island Transmission Link. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2010f. Avifauna Component Study, Labrador – Island Transmission Link. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2011a. Labrador Transmission Corridor Option: Muskrat Falls to the Strait of Belle Isle. Labrador – Island Transmission Link. Vegetation Supplementary Report. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2011b. Timber Resources. Labrador – Island Transmission Link. Final Report. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2011c. 2011 Listed and Regionally Uncommon Plant Survey: Strait of Belle Isle Cable Landing Areas and Shore Electrode Sites Supplementary Report. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2011d. *Labrador-Island Transmission Link* Caribou and Their Predators Component Study. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2011e. Furbearer and Small Mammal Supplementary Report for the Labrador-Island Transmission Link. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2011f. Avifauna Component Study Supplementary Report, Labrador – Island Transmission Link. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2012a. Labrador – Island Transmission Link: Caribou and Other Large Mammals Component Study - Revised. Prepared for Nalcor Energy. St. John's, NL.

Stantec. 2012b. Labrador – Island Transmission Link: Avifauna Component Study - Revised. Prepared for Nalcor Energy. St. John's, NL.

Stassinu Stantec Limited Partnership. 2010. Survey Population Trends of the Harlequin Duck in Labrador. Prepared for Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, NL.

Steininger, F. 1952. Rodent Control and secondary Poisoning of Birds of Prey and Owls. Ornithologische Mitteilungen 4: 36-39.

Stuart-Smith, A.K., C.J.A. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. 1997. Woodland Caribou Relative to Landscape Patterns in Northeastern Alberta. Journal of Wildlife Management. 61: 622-633.

Sturtevant, B.R. and J.A. Bissonette. 1996. An Examination of Second Growth Forest as Potential Marten Habitat in Western Newfoundland. 94pp.

Sturtevant, B.R., J.A. Bissonette and J.N. Long. 1996. Temporal and Spatial Dynamics of Boreal Forest Structure in Western Newfoundland: Silvicultual Implications for Marten Habitat Management. Forest Ecology and Management 87: 13-25.

Sweitzer, R.A. 1996. Predation or Starvation: Consequences of Foraging Decisions by Porcupines (*Erithozon dorsatum*). Journal of Mammalogy 77: 1068 – 1077.

Thibodeau, F.R. and N.H. Nickerson. 1986. Impact of Power Utility Rights-of-Way on Wooded Wetland. Environmental Management. 10: 809-814

Thomas, P. 2008. Harlequin ducks in Newfoundland. Waterbirds 31 (Special Publication 2): 44-49.

Thomas, D.C. and D.R. Gray. 2002. Update COSEWIC status report on the woodland caribou *Rangifer tarandus caribou* in Canada, in COSEWIC assessment and update status report on the Woodland Caribou *Rangifer tarandus caribou* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-98 pp. Available at: http://www.cpaws-sask.org/common/pdfs/cosewic_woodland_caribou_report_thomas_Gray_2002.pdf.

Thompson, I.D. 1994. Marten populations in uncut and logged boreal forests in Ontario. Journal of Wildlife Management 58:272-280.

Thompson, I.D. and W.J Curran. 1995. Habitat Suitability for Marten of Second-growth Balsam Fir Forest in Newfoundland. Canadian Journal of Zoology 73: 2059-2064.

Thompson, I.D., I.J. Davidson, S. O'Donnell and F. Brazeau. 1989. Use of Track Transects to Measure the Relative Occurrence of Some Boreal Mammals in Incut Forest and Regeneration Stands. Canadian Journal of Zoology 67: 1816-1823.

Thompson, I.D., H. A. Hogan and W.A. Montevecchi. 1999. Avian Communities of Mature Balsam Fir Forests in Newfoundland: Age-dependence and Implications for Timber Harvesting. The Condor 103:311-323.

Todd, W.E.C. 1963. Birds of the Labrador Peninsula. Carnegie Museum and University of Toronto Press, Canada.

Transport Canada and Fisheries and Oceans Canada (DFO). 2007. Comprehensive Study Report: Southern Head Marine Terminal and Associated Works Related to the Crude Oil Refiner Development proposal. Prepared by SNC-Lavalin Inc.

Trimper, P.G., P. Thomas and T.E. Chubbs. 2008. Harlequin Ducks in Labrador. Waterbirds 31 (Special Publication 2): 32-43.

Trimper, P.G., N. Standen, L.M. Lye, D. Lemon, T.E. Chubbs and G. Humphries. 1998a. Effects of Low-level Jet Aircraft Noise on the Behaviour of Nesting Osprey. Journal of Applied Ecology 25: 122-130.

Trimper, P.G., T.E. Chubbs, N.M. Standen and G.W. Humphries. 1998b. Effects of Intensive Aircraft Activity on the Behaviour of Nesting Osprey. 7th International Congress on Noise as a Public Health Problem, ICBEN, Sydney, Australia.

Trombulak, S. and C.A. Frissell. 1999. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology. 14(1): 18-30. Available at: http://onlinelibrary.wiley.com/doi/10.1046/j.1523-1739.2000.99084.x/pdf.

Tucker, B.J. 1988. The Effects of Forest Harvesting on Small Mammals in Western Newfoundland and its Significance to Marten. Utah State University, Logan, UT.

Underhill, J.E. and P.G. Agnold. 2000. Effects of Roads on Wildlife in an Intensively Modified Landscape. Environ. Rev. 8: 21-39 (2000).

USFWS (United States Fish and Wildlife Service). 2010. Bald Eagle Management Guidelines and Conservation Measures, Bald Eagle Natural History and Sensitivity to Human Activity Information. Available at: http://www.fws.gov/midwest/eagle/guidelines/baea_nhstry_snstvty.html. Last updated March 31, 2010. Accessed: April 2011.

Vale Inco Newfoundland and Labrador Limited. 2008. Long Harbour Commercial Nickel Processing Plant EIS. St. John's, NL.

Vana-Miller, S.L. 1987. Habitat Suitability Models: Osprey. US Fish and Wildlife Service Biological Report 82: 46 pp.

Van Daele, L.J. and H.A. Van Daele. 1982. Factors Affecting the Productivity of Ospreys Nesting in West-central Idaho. Condor 84: 292-299.

Van der Ree, R., N. Gulle, K. Holland, E. van der Grift, C. Mata and F. Suarez. 2007. "Overcoming the barrier effect of roads – how effective are mitigation strategies?". In C. L. Irwin, D. Nelson, and K. P. McDermott (ed.). Proceedings of the 2007 International Conference on Ecology and Transportation. Raleigh, NC: Centre for Transportation and the Environment, North Carolina State University, 2007. pp 423-431.

Vistnes, I. and C. Nellemann. 2001. Avoidance of Cabins, Roads, and Power Lines by Reindeer during Calving. Journal of Wildlife Management 65: 915-925.

Vistnes, I., C. Nelleman, P. Jordhøy and O. Strand. 2004. Effects of Infrastructure on Migration and Range Use of Wild Reindeer. Journal of Wildlife Management 68: 101-108.

Voigt, D.R. 1987. Red fox. In M. Novak, J.A. Baker, M.E. Obbard and B. Malloch (ed). Wildlfurbearer Management and Conservation in North America. Ministry of Natural Resources, Toronto, ON.

Vors, L.S., J.A. Schaefer, B.A. Pond, A.R. Rodgers and B.R. Patterson. 2007. Woodland Caribou Extirpation and Anthropogenic Landscape Disturbance in Ontario. Journal of Wildlife Management 71: 1249-1256.

Wallen, R.L. 1987. Habitat utilization by Harlequin Ducks in Grand Teton National Park. Master's thesis, Montana State University Bozeman.

Walley, W.J. 1989. Breeding Blackpoll Warblers, *Dendroica striata*, in Duck Mountain Provincial Park, Manitoba. Canadian Field Naturalist 103: 396-397.

Ward, D.H., R.A. Stehn, D.V. Derksen, C.J. Lensink and A.J. Lorange. 1986. Behaviour of Pacific Black Brant and Other Geese in Response to Aircraft Overflights and Other Disturbance at Izembek Lagoon, Alaska, U.S. Fish and Wildl. Servl, Alaska Fish and Wildl. Res. Center, Anchorage, AK. Unpubl. Rep. 34 p.

Warkentin, I. and S. Newton. 2009. Birds of Newfoundland Field Guide. Boulder Publications. Portugal Cove-St. John's, NL.

Warren, P.S., M. Katti and A. Brazel. 2006. Urban Bioacoustics: It's Not Just Noise. Animal Behaviour 71: 491-502.

Wells, E.D. and H.E. Hirvonen. 1988 Wetlands of Atlantic Canada. Pp. 249-303. Cited in: National Wetlands Working Group. 1988. Wetlands of Canada. Published by Ecological Land Classification Series, No. 24, Sustainable Development Branch, Environment Canada, Ottawa, ON, and Polyscience Publications Inc., Montreal, QC. 425 pp.

Weir, J.N., S.P. Mahoney, B. McLaren and S.H. Ferguson. 2007. Effects of Mine Development on Woodland Caribou *Rangifer tarandus* distribution. Wildlife Biology 13: 66-74.

Wheelwright, N.T. and J.D. Rising. 2008. Savannah Sparrow (*Passerculus sandwichensis*). In A. Poole and F. Gill (ed.). The Birds of North America, No. 45, The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, DC.

Whitaker, D.M. and W.A. Montevecchi. 1999. Breeding Bird Assemblages in Habiting Riparian Buffer Strips in Newfoundland, Canada. Journal of Wildlife Management 63: 167-179.

Whitaker, D.M., P.D. Taylor and I.G. Warkentin. 2008. Survival of Adult Songbirds in Boreal Forest Landscapes Fragmented by Clearcuts and Natural Openings. Avian Conservation and Ecology 3(1): 5.

Wiggins, D.A., D.W. Holt and S.M. Leasure. 2006. Short-eared Owl (*Asio flammeus*). In A. Poole (ed.). The Birds of North America Online, Cornell Lab of Ornithology, Ithaca. Available at: http://bna.birds.cornell.edu/bna/species/062.

Wilkerson, C.D. 2010. Population Genetics of Woodland Caribou (*Rangifer tarandus caribou*) on the Island of Newfoundland. M.Sc. Thesis, Memorial University of Newfoundland, St. John's, NL.

Wittmer, H.U., B.N. McLellan, R. Serrouya and C.D. Apps. 2007. Changes in Landscape Composition Influence the Decline of a Threatened Woodland Caribou Population. Journal of Animal Ecology 76: 586-579.

Wolfe, S.A., B. Griffith and C.A.G. Wolfe. 2000. Response of Reindeer and Caribou to Human Activities. Polar Research 19: 63-73.

Wood, W.E. and S.M. Yezerinac. 2006. Song Sparrow Songs Varies with Urban Noise. The Auk 123(3): 650-659.

Wray, T., K.A. Strait and R.C. Whitmore. 1982. Reproductive Success of Grassland Sparrows on a Reclaimed Surface Mine in West Virginia. Auk 99: 157-164.

Yahner, R. 2004. Wildlife Response to More than 50 years of Vegetation Maintenance on a Pennsylvania US Right-of-Way. Journal of Arboculture 30(2): March 2004, 123-126.

Yukon Renewable Resources. 1996. Woodland Caribou Management Guidelines. Whitehorse, Yukon. Available at: http://www.yfwcm.ca/species/caribou/guidelines.php. Accessed: March 24, 2011.

Zielinski, W.J., K. Slauson and A.E. Bowles. 2008. Effects of Off-highway Vehicle Use on the American Marten. Journal of Wildlife Management 72(7): 1558 - 1571.

NALCOR ENERGY

LABRADOR-ISLAND TRANSMISSION LINK

ENVIRONMENTAL IMPACT STATEMENT

Chapter 13

Freshwater Environment: Environmental Effects Assessment

April 2012

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

Acronym	Description
%	percent
µg/L	micrograms per litre
µS/cm	microSeimens per centimetre
AMEC	AMEC Earth & Environmental
BTEX	benzene, toluene, ethylbenzene and xylene
CANAL	Canada-Newfoundland / Labrador Aqua Link
CCME	Canadian Council of Ministers of the Environment
CEA Agency	Canadian Environmental Assessment Agency
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada
DO	dissolved oxygen
EA	Environmental Assessment
EEM	Environmental Effects Monitoring
EIS	Environmental Impact Statement
EPP	Environmental Protection Plan
g/m^3	grams per cubic metre
GCDWQ	Guidelines for Canadian Drinking Water Quality
GNL	Government of Newfoundland and Labrador
ISO	International Standards Organization
KI	Key Indicator
km	kilometre
km^2	square kilometres
LSA	Local Study Area
m	metre
m/hr	metres per hour
m/s	metres per second
m^2	square metre
mg/L	milligrams per litre
mm	millimetre
MP	Measurable Parameter
NL	Newfoundland and Labrador
NLDEC	Newfoundland and Labrador Department of Environment and Conservation
NLEPA	*Newfoundland and Labrador Environmental Protection Act*
NLESA	*Newfoundland and Labrador Endangered Species Act*
NLOS	Newfoundland and Labrador Operational Statements
PAL	Guidelines for the Protection of Aquatic Life
Project	Labrador-Island Transmission Link

Acronym	**Description**
ROW	right-of-way
RSA	Regional Study Area
SARA	*Species at Risk Act*
SHERP	Safety, Health and Environment Emergency Response Plan
SSCC	Species of Special Conservation Concern
TCH	Trans-Canada Highway
TLH3	Trans-Labrador Highway Phase 3
TPH	total petroleum hydrocarbons
TSS	total suspended solids
VEC	Valued Environmental Component
VOC	volatile organic compound

13 FRESHWATER ENVIRONMENT: ENVIRONMENTAL EFFECTS ASSESSMENT

This Chapter of the Environmental Impact Statement (EIS) presents the environmental assessment for the Freshwater Environment, which includes freshwater resources, and fish and fish habitat.

13.1 Valued Environmental Component Selection

The environmental assessment (EA) is focused on Valued Environmental Components (VECs). VECs are aspects of the biophysical and socioeconomic environments which are of particular ecological or social importance, and which have the potential to be affected (adversely or positively) by the proposed Labrador-Island Transmission Link (Project) under assessment. VECs reflect identified scientific and community concerns regarding the Project and its potential effects, and are identified early in an EA as a result of questions and issues raised through consultations with governments, Aboriginal and stakeholder groups and the general public.

Initial direction and input into VEC selection for this EIS were obtained through the EIS Guidelines and Scoping Document (May 2011) that were issued to Nalcor Energy (Nalcor) by the federal and provincial governments following Aboriginal and public review. Following additional analysis by the EIS study team and as a result of Nalcor's own consultation activities, that initial list of VECs has been expanded and refined to include and reflect the key environmental components and issues that require detailed consideration in the EIS.

The ecosystem components of the Freshwater Environment requiring protection are the major constituents of freshwater habitat that are required to maintain environmental integrity, and the species that utilize the freshwater habitat. The VECs that have been selected as the focus for the environmental assessment for the Freshwater Environment, as well as the rationale for their selection, are described below.

Freshwater Resources

Freshwater Resources are defined as bodies of surface water including streams, lakes, ponds and wetlands. Freshwater Resources were selected as a VEC because of their importance to human life (i.e., drinking water) and ecosystem function, and because they provide a pathway for interactions between the Project and other VECs. The potential interaction between the Project and existing freshwater resources could occur within both the Project footprint and in adjacent habitat. Negative effects on Freshwater Resources, including effects on water quality and quantity, could occur during all phases of the Project.

Fish and Fish Habitat

Fish and Fish Habitat includes all fish species that inhabit the Freshwater Environment, as well as physical habitat characteristics of the waterbody, and the adjacent riparian zone that may be affected by the Project. The chemical and physical properties of the water itself are considered under the Freshwater Resources VEC. Elements of fish habitat include substrate composition, bed stability, degree of substrate embeddedness with fine material, water depth, water velocity and the amount of overhead and lateral cover. This VEC was selected because healthy and sustainable freshwater fish populations and fish habitat are valued from an ecological, economic and sustenance point of view, and because federally or provincially-listed fish species of conservation concern may occur in waterbodies crossed by the Project (Section 10.4.5). Potential interactions between the Project and Fish and Fish Habitat could occur both within the Project footprint and in adjacent habitat. Negative effects on Fish and Fish Habitat could occur during all phases of the Project.

The effects of the Project on these VECs are assessed in the following sections of this chapter.

Species of Special Conservation Concern (SSCC) are an integral component of the effects analysis. Freshwater fish SSCC are addressed in this chapter and the manner in which each species is considered in the EA is outlined in Table 13.1-1. This list includes consideration of all potential fish species known to occur in the Study Area (as defined in Section 10.4.5) and protected under the federal *Species at Risk Act* (*SARA*) (*SARA* 2011, internet site) or *Newfoundland and Labrador Endangered Species Act* (*NLESA*) (Government of Newfoundland and Labrador (GNL) 2011, internet site), as well as those species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2011, internet site) or assessed by the Species Status Advisory Committee (SSAC) (Newfoundland and Labrador Department of Environment and Conservation (NLDEC) 2011a, internet site), for the Freshwater Environment.

Table 13.1-1 Integral Consideration of Species of Special Conservation Concern in the Environmental Assessment – Freshwater Environment

Species of Special Conservation Concern[a]	How Species is Addressed in the EIS
American eel[b]	Assessed in the Fish Abundance and Species Assemblage Key Indicator (KI) of the Fish and Fish Habitat VEC

[a] Only SSCC that are expected to be present within the Study Area are included in this analysis. See Chapter 10 Existing Biophysical Environment (Section 10.4.6 and Table 10.5.10-10) for information about species presence.

[b] American eel is also addressed in Section 14.2 under Marine Environment, in the Fish KI of the Marine Fish and Fish Habitat VEC.

13.2 Freshwater Resources

13.2.1 Introduction

Freshwater Resources have important social, ecological and economic roles. Fresh water provides settings for human recreation (e.g., fishing, swimming), habitat and sustenance for fish and wildlife health and productivity, and food and potable water for human consumption. Various economic generators such as sport fishing, canoeing, rafting, hiking and camping are possible because of the existence of healthy freshwater resources.

The Construction, and Operations and Maintenance phases of this Project have the potential to affect water resources and their associated benefits through negative changes to water quality or quantity. Changes in freshwater quality and quantity can be an indicator of changes to environmental health, and can lead to interactions between the Project and other ecosystem components such as aquatic and semi-aquatic organisms. Degradation of Freshwater Resources could cause concern among all stakeholders.

Primary potential pathways between the Project and Freshwater Resources are activities near or within waterbodies such that water quality or quantity is affected. The transmission corridor crosses a total of 586 streams in the four land-based regions within the province. Public water supply areas and wetlands crossed by the corridor are addressed in detail in Sections 16.3 (Communities) and 16.5 (Land and Resource Use) and 12.2 (Vegetation). Potential sensitive locations include nearby protected areas, such as the Main River.

Water quality is protected and regulated under federal legislation such as the *Canadian Environmental Protection Act*, the *Fisheries Act* and provincial regulations for Environmental Control Water and Sewer Regulations under the *Water Resources Act*. Public water supplies and the land surrounding a waterbody are further protected under the provincial *Water Resources Act*. Any existing or proposed development within a protected water supply area is subject to the Policy for Land and Water Related Developments in Protected Public Water Supply Areas (NLDEC 1999, internet site). The policy identifies activities that are not permitted in protected water supply areas and activities that may be permitted subject to approval of the NLDEC. Subject to approval of the NLDEC, development activities (including constructing stream crossings and power and telecommunication transmission lines) may be permitted in public water supply areas. In general, these regulations control and limit quantities and types of substances (or objects) that can enter a water source to prevent significant effects.

Health Canada, on behalf of the Federal-Provincial-Territorial Committee on Drinking Water, regularly updates and publishes the *Guidelines for Canadian Drinking Water Quality* (GCDWG) (Health Canada 2010). These are health-based guidelines specific to health effects, aesthetic effects and operational considerations for drinking water management issues or emergency situations. These guidelines have been established for Canadian drinking water quality and are specific to contaminants that could lead to adverse health effects, are frequently detected or have a high likelihood of occurring in drinking water supplies in Canada, or are detected or expected to be detected at levels causing adverse health effects.

Development activities in and around wetlands are indirectly regulated at the federal level through protection of species and habitats specific to wetlands under authority of the *Canadian Wildlife Act*, *the Fisheries Act*, *the Migratory Birds Convention Act*, *SARA*, and *the Canadian Environmental Assessment Act*. In addition, under provincial authority of the *Water Resources Act* (NLDEC 2002, internet site) and its general policy for development in wetlands (NLDEC 2001, internet site), the province regulates all developments in wetlands. To prevent significant effects on wetlands, the *Water Resources Act* (Part II, Section 30(2)) and Sections 5(1) and 5(2) of the associated *Environmental Control Water and Sewage Regulations*, 2003 (O.C. 2003-231) identify controls to wastewater and stormwater discharges into a wetland, and chemical and biological alterations of a wetland. Refer to Section 12.2 (Vegetation) for additional information on wetlands and to Section 16.3 (Communities) and Section 16.5 (Land and Resource Use) for measures to protect public water supply watersheds.

As detailed in Section 10.4 (Existing Environment), data from water samples collected during the baseline sampling program (AMEC Earth and Environmental (AMEC) 2010) indicate that in undeveloped areas within the corridor, water quality is typical for the province. Water samples were collected at 44 of the 53 sites that were field surveyed in 2008, and analyzed for general chemistry, metals, volatile organic compounds (VOC), BTEX (benzene, toluene, ethylbenzene and xylene) and total petroleum hydrocarbons (TPH) (AMEC 2010) (see Table 10.4.4-1 in this EIS). Samples collected from waterbodies near developed areas such as roads and industrial sites had generally higher concentrations of BTEX, VOC or TPH. No result exceeded the Canadian Council of Ministers for the Environment (CCME) *Guidelines for the Protection of Freshwater Aquatic Life* (PAL) (CCME 2002) for BTEX or VOCs, and there are currently no guidelines for TPH. Analysis of metal parameters in samples from 43 of the 44 sites had at least one parameter that exceeded CCME PAL guidelines (AMEC 2010).

The NLDEC collects information on water quantity which is largely seasonal. The highest flows are observed in the spring and fall months due to high rainfall and snow melt events. Mean annual runoff is highest in the south-western region of Newfoundland, where it ranges from 1,300 millimetres (mm) to 2,100 mm. The lowest mean annual runoff is between 700 mm and 900 mm, and occurs in the north-central area of the Island. On the Avalon and Burin peninsulas, the range of mean annual runoff is from 1,100 mm to 1,900 mm, while on the Northern Peninsula it is between 1,100 mm and 1,400 mm. Mean annual runoff in Labrador ranges from 600 mm to 800 mm, with the exception of the extreme south-eastern corner where it is over 1,000 mm (NLDEC 2011b, internet site). A discussion of water resources by region is presented below.

13.2.1.1 Central and Southeastern Labrador

A total of 194 watercourses are crossed by the transmission corridor in this region that extends from the south side of the Churchill River to the Strait of Belle Isle. Large watercourses or sections of their watersheds that the corridor will cross include the Churchill River, Kenamu River and St. Paul River (AMEC 2010). The majority of this region remains undeveloped with the exception of the Trans-Labrador Highway Phase 3 (TLH3), several small local or woods roads and recreational vehicle trails. Roads and recreational vehicle trails increase the potential for sediment and other particulate matter to enter watercourses. Spills and leaks from vehicles travelling on these roads also pose a potential risk for release of hydrocarbons.

Water resources sampled in this region were typical of the province, showing exceedances to CCME PAL guidelines for metals, primarily aluminum, cadmium and iron and, less frequently, copper, lead and mercury (AMEC 2010). General chemistry results indicate pH values are just below neutral (average pH of field surveyed sampled sites was 6.58), and conductivity of the water is fairly low (average conductivity of sampled sites is 23 microSiemens per centimetre (µS/cm) (AMEC 2010). Low water conductivity values indicate lower concentrations of dissolved salts, metals and nutrients in the water.

13.2.1.2 Northern Peninsula

A total of 123 watercourses are crossed by the transmission corridor, most in undeveloped areas including the upstream portions of the Main River watershed; the Main River is a designated Heritage River. Other large watercourses or sections of their watersheds that the corridor will cross include Portland Creek, Castors River, Torrent River, River of Ponds, Sop's Arm River, Humber River and Hampden River (AMEC 2010). Sections of two major highways, Routes 430 and 432, and numerous local and woods roads and recreational trails cross the proposed corridor. Roads and recreational vehicle trails increase the potential for sediment and other particulate matter to enter watercourses. Spills and leaks from vehicles travelling on these roads also pose a potential risk for the release of hydrocarbons.

Water resources sampled in this region showed exceedances to CCME PAL guidelines for metals, primarily aluminum and cadmium and, less frequently, copper and iron (AMEC 2010). General chemistry results indicate pH values average around neutral (average pH of field surveyed sampled sites is 7.02) and conductivity of the water is moderate (average conductivity of field surveyed sampled sites is 69 µS/cm) (AMEC 2010).

13.2.1.3 Central and Eastern Newfoundland

There are 170 watercourses crossed by the transmission corridor within this region, in both developed and undeveloped areas. Large watercourses or sections of their watersheds that the corridor will cross include the Humber River watershed, Exploits River and Gander River. Major highways in and around the corridor include the Trans-Canada Highway (TCH) and Highways 370, 360, and 301. Various woods roads and trails for recreational vehicles are also crossed by the corridor. Roads and recreational vehicle trails increase the potential for sediment and other particulate matter to enter watercourses. Spills and leaks from vehicles travelling on these roads also pose a potential risk for release of hydrocarbons.

Water resources sampled in this region demonstrated exceedances to CCME PAL guidelines for metals, primarily aluminum and cadmium and, less frequently, selenium (AMEC 2010). General chemistry results indicate pH values just below neutral (average pH of field surveyed sampled sites is 6.43) and conductivity of the water is low (average conductivity of field surveyed sampled sites is 20.6 µS/cm) (AMEC 2010).

13.2.1.4 Avalon Peninsula

A total of 99 watercourses are crossed by the transmission corridor from east of Port Blandford to Soldiers Pond located south of the town of Conception Bay South. Large watercourses or sections of their watersheds that the corridor will cross include the Northern Arm River, Southwest Brook, Southwest River, Spread Eagle River and Witch Hazel Brook (AMEC 2010). The majority of the corridor in this region is developed, with numerous communities and larger towns flanking either side of the corridor. Highways and major roads crossed by the corridor include the TCH and Highway 202, along with several smaller roads and trails. Roads and recreational vehicle trails increase the potential for sediment and other particulate matter to enter watercourses. Spills and leaks from vehicles travelling on these roads also pose a potential risk for release of hydrocarbons.

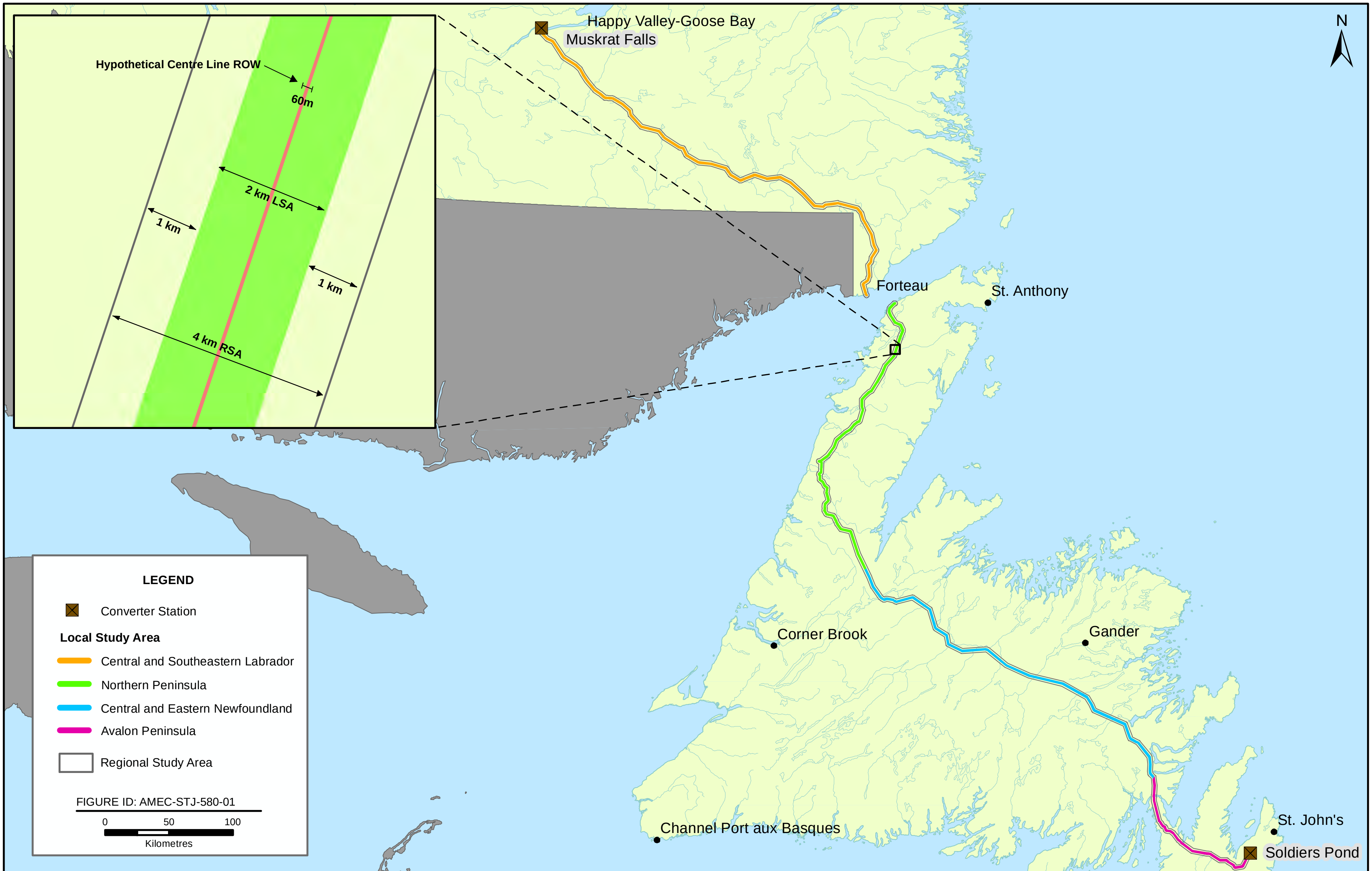
Typical of the region, water resources sampled in this region showed exceeded values of CCME PAL guidelines for aluminum and cadmium (AMEC 2010). General chemistry results indicate pH values are just below neutral (average pH of field surveyed sampled sites is 6.59) and conductivity of the water is fairly low (average conductivity of field surveyed sampled sites is 37.5 µS/cm) (AMEC 2010).

13.2.2 Environmental Assessment Study Areas

13.2.2.1 Spatial Boundaries

The spatial boundaries used in the assessment reflect the nature and potential extent of Freshwater Resources and likely Project-related effects, administrative or management zones, and areas for which information is available. These boundaries are consistent with an identifiable ecological boundary (i.e., within the extent and riparian boundary of a watercourse).

The Local Study Area (LSA) is the area where Project-related components and activities that may affect water resources will occur. The LSA therefore includes the 2 km wide transmission corridor while also considering the general nature and location of other Project activities and components (e.g., access, electrode sites, camps, and storage areas) (Figure 13.2.2-1).



nalcor energy

FIGURE 13.2.2-1

Local and Regional Study Areas for Freshwater Resources and Fish and Fish Habitat

The Regional Study Area (RSA) encompasses the spatial extent of the Project's potential effects on Freshwater Resources (e.g., the potential zone of influence) (Figure 13.2.2-1). For example, based on a settling rate for silt of 0.88 metres per hour (m/hr) (Minaskuat Inc. 2008) a suspension of material in water 0.5 metres (m) deep and a flow rate of 0.2 metres per second (m/s), would travel for approximately 450 m. A conservative RSA would therefore be 1,000 m of watercourse downstream from any site at which Project activities could affect water resources; therefore, the RSA encompasses an additional 1 km wide buffer along both sides of the LSA. In addition, considering that appropriate mitigation measures will be implemented (including availability of a spill kit on-site at all times), any accidental spill of hydrocarbons during stream crossing activities would be contained within this area.

13.2.2.2 Temporal Boundaries

Temporal boundaries for Freshwater Resources are as defined in the EA Methods chapter (Section 9.3.2), encompassing the Construction phase (period between the start of Construction and Project commissioning – approximately four years) and Operations and Maintenance phase (indeterminate period following Project commissioning).

13.2.3 Potential Environmental Issues, Indicators and Interactions

13.2.3.1 Potential Environmental Issues

Table 13.2.3-1 outlines the issues associated with the Project and Freshwater Resources, as identified in the EIS Guidelines and Scoping Document (May 2011), through regulatory, Aboriginal and stakeholder consultation, and by the EIS study team. It is likely that the issues will be the same for each of the four land-based regions of the Project corridor; therefore, the regions are not addressed separately.

Disturbance of riparian habitat during access trail or road development, culvert or bridge installation and fording activities can increase erosion of stream bank soils or transportation of fine material from exposed areas into freshwater streams if appropriate erosion control measures are not in place. The potential for this effect to occur is also seasonally dependant (i.e., less risk under frozen ground or snow covered conditions). Effects during Construction will occur when equipment and crews are physically fording each required stream location; however, fording will occur periodically at each location as construction continues along the right-of-way (ROW), and equipment are limited to fording smaller sized watercourses for safety and permitting reasons. Permitted crossing locations will be selected so as to minimize adverse effects on the watercourse due to crossing, respecting the location relative to the ROW. Excess siltation can have a negative effect on water quality and the health of freshwater biota. Deposition of airborne fine material (i.e., dust) can also affect watercourses. Vegetation removal can have effects on the Freshwater Environment, and accidental contamination is an issue.

No issues have been identified with respect to the interaction of the Project with water quantity, as standard mitigation associated with Project components (e.g., access road and bridge construction, towers, and converter station construction) will apply. Application of such mitigation measures will minimize the potential for rutting, damming or redirection of water during high flow events such as snow melt and heavy rainfall. All stream crossings, including culverts, will be constructed and sized so as not to impede water flow and hydrologic regime of the watercourses, and in compliance with applicable regulatory requirements.

Table 13.2.3-1 Identified Issues and Questions: Freshwater Resources

Issue / Question	Nature and Rationale	Specific Considerations
Sedimentation	– Increased Total Suspended Solids (TSS) resulting from streambed disturbance or soil erosion during fording and installation of stream crossings (i.e., culverts, temporary bridges or permanent bridges); TSS in the water column reduces water quality, in turn affecting freshwater organisms and drinking water – Sedimentation in the water column can reduce water clarity and cause permanent damage (gill abrasion) in fish (Gosse et al. 1998) – Sediment deposition can smother fish eggs and alevins if occurring during spawning, incubation or hatching periods – Sediment deposition can affect benthic invertebrates through loss of available habitat in interstitial spaces, and through impaired respiration	– Especially important during sensitive life-cycle stages of aquatic organisms such as spawning and egg incubation, or within drinking water supplies – Sediment deposition is particularly severe in areas with low flows or lower water velocities
Vegetation removal	– Removal of riparian vegetation during preparation of the ROW, as well as access roads, fording sites and stream crossings, can remove shading from fish habitat, create unstable soil conditions, and reduce bank stability; this can result in soil or bank erosion and increased TSS – Removal of vegetation can lead to increased nutrient input into the water column, which can increase plant growth leading to a depression in dissolved oxygen (DO) – Removal of vegetative cover can alter the temperature regime of a waterbody	– Especially important during sensitive life-cycle stages of aquatic organisms such as spawning and egg incubation – Vegetation removal can be particularly important during low flows
Contamination	– Spills and / or leaks from equipment during Project activities such as fording, vegetation clearing, and re-fuelling could affect water quality by the introduction of hydrocarbons – Management of vegetation by spraying may result in the introduction of contaminants (herbicides) into waterbodies	– Effects of contamination are exacerbated during low flow conditions, leading to further impairment in water quality during times of low water quantity – Would be of particular concern within drinking water supplies – Herbicide selection should take into consideration the toxicity to non-target species

13.2.3.2 Key Indicators and Measurable Parameters

Interactions between Freshwater Resources and the Project are related to activities undertaken near or within waterbodies that affect water quality. Therefore, Water Quality has been selected as the Key Indicator (KI) to represent the Freshwater Resources VEC. This KI helps to frame and focus the assessment on the potential environmental issues that were identified in Table 13.2.3-1. The Project is not likely to have an effect on water quantity based on the nature of the Project (i.e., crossing and spanning watercourses). Therefore, water quantity is not considered further in this assessment.

Water quality consists of chemical and physical characteristics which can affect the sustainability of aquatic and terrestrial life. It is a vital component of the Freshwater Environment. Changes in freshwater quality can influence aquatic environments and fish species presence, and is typically used as an indicator of aquatic ecosystem health.

Data on the Water Quality KI in the Project area (physical and chemical parameters, major ions, nutrients, trace elements and metals) are available through the Canada-Newfoundland / Labrador Aqua Link (CANAL) (Environment Canada 2007, internet site). CANAL is an on-line database providing access to co-ordinated and standardized water quality data collected at monitoring sites province-wide. This water quality monitoring program has been established through the Canada-Newfoundland Water Quality Monitoring Agreement, a co-operative agreement co-ordinating federal and provincial water monitoring activities. In addition, data relative to the Water Quality KI from drinking water supplies in the province are collected and managed by the NLDEC, Water Resources Division. Water samples are taken annually from long-term monitoring stations and analyzed for physical parameters, major ions, nutrients and metals on a routine basis.

Measurable water quality parameters can be analyzed to determine existing water quality conditions, and to detect any changes that occur as a result of the Project. Measurable Parameters (MP) for the Water Quality KI are outlined in Table 13.2.3-2.

Table 13.2.3-2 Key Indicators and Associated Measurable Parameters: Freshwater Resources

Key Indicator	Rationale for Key Indicator[a]	Measurable Parameter[b]	Rationale for Measurable Parameter
Water Quality	Water quality is directly related to health of aquatic and semi-aquatic life and to the quality of drinking water for wildlife and humans; adherence to CCME[c] guidelines for water quality; *Water Resources Act*[e] compliance	Changes in TSS (milligrams per litre(mg/L)) within and downstream of the Project footprint	– Increase in TSS is a direct measure of a change in water quality that could negatively affect Freshwater Resources – Can be directly compared to regulatory guidelines and limits such as CCME[c], GCDWQ[d] and the *Water Resources Act*[e]
		Herbicide levels (micrograms per litre (µg/L)) within and downstream of the Project footprint	– Presence of herbicidal chemicals is a direct measure of a change in water quality that could negatively affect Freshwater Resources – Many common herbicides can be directly compared to regulatory guidelines and limits such as CCME[c], GCDWQ[d] and the *Water Resources Act*[e]
		Changes in nitrogen and phosphorous levels (mg/L) within and downstream of the Project footprint	– Nitrogen and phosphorous are indicators of nutrients in water; increased levels indicate a negative effect on Water Quality – Can be directly compared to regulatory guidelines and limits such as CCME[c], GCDWQ[d] and the *Water Resources Act*[e]
		Changes in toluene or ethylbenzene levels (µg/L) within and downstream of the Project footprint	– Toluene and ethylbenzene are short-term indicators of fuel release (they dissipate within weeks by volatilization and biodegradation) – Identifies inputs of hydrocarbons into the water resulting from a recent spill or leak, or as a result of Project activities (i.e., during chemical spraying for vegetation management) that could negatively affect water quality – Can be directly compared to regulatory guidelines and limits such as CCME[c], GCDWQ[d] and the *Water Resources Act*[e]

(a) Key Indicator: An aspect or characteristic of the VEC and / or its environment which, if changed as a result of the Project, may result in an effect on the VEC.
(b) Measurable Parameter: An environmental characteristic which is related to the status of a KI. Project effects to a measurable parameter can be detected and measured.
(c) CCME (PAL) (2002).
(d) GCDWQ (Health Canada 2010).
(e) *Water Resources Act* (NLDEC 2002, internet site).

13.2.3.3 Potential Project-Water Resources Interactions

The potential Project effects on Water Quality are well understood, with practical and effective mitigation readily known and applicable. With the proposed mitigation in place, Project interactions with Freshwater Resources are related specifically to fording activities, stream crossings, vegetation removal and accidental release of hydrocarbons associated with Construction, and Operations and Maintenance. A summary of interactions, in consideration of proposed mitigation, is provided in Table 13.2.3-3.

Table 13.2.3-3 Potential Project Interactions: Freshwater Resources

Project Phase / Activity	Key Indicator
	Water Quality
Construction	
Construction of access trails and roads including stream crossings (i.e., culverts, temporary bridges and permanent bridges); does not include fording, but includes preparation of fording location	– Vegetation removal or disturbance and soil exposure could result in erosion, leading to an increase in nutrients and particulate matter in the water column – Installation of culverts, temporary bridges and permanent bridges may result in increased particulate matter entering a watercourse – Rutting, tracking and soil disturbance could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse
Movement and presence of personnel, equipment and materials; includes fording	– Fording of equipment and personnel could cause suspension of silt and particulate matter in the water column – Rutting and tracking resulting in exposure or transfer of soils could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons could enter a watercourse, either directly (during equipment fording) or through run-off from accidental release of fuel or lubricants near a watercourse
Construction camps	– Vegetation removal or disturbance and resulting soil exposure near construction camps could result in erosion, leading to an increase in particulate matter in the water column – Wastewater from construction camps may enter a watercourse if not properly managed – Spills or leaks of hydrocarbons could enter a watercourse through run-off from accidental release of fuel or lubricants at the camp
Marshalling yards and staging areas	– Vegetation removal or disturbance and resulting soil exposure near marshalling yards and staging areas could result in erosion, leading to an increase in particulate matter in the water column – Wastewater from marshalling yards and staging areas may enter a watercourse if not properly managed – Spills or leaks of hydrocarbons could enter a watercourse through run-off from accidental release of fuel or lubricants at these sites

Table 13.2.3-3 Potential Project Interactions: Freshwater Resources (continued)

Project Phase / Activity	Key Indicator: Water Quality
Right of way clearing and preparation	– Vegetation removal or disturbance and resulting soil exposure could result in erosion, leading to an increase in nutrients and particulate matter in the water column – Rutting, tracking and soil disturbance could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse
Quarrying and borrowing	—
Transmission tower assembly and installation	– Fording of equipment and personnel could cause suspension of silt and particulate matter in the water column – Rutting, tracking and soil disturbance could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse
Conductor installation	
Converter station site preparation and construction	—
Preparation and construction of submarine cable landing sites (on-land works)	
Construction and installation of submarine cables (marine works)	
Electrode site preparation and installation	
Island system upgrades (fording at existing permitted locations)	– Fording of equipment and personnel could cause suspension of silt and particulate matter in the water column – Rutting and tracking resulting in exposure or transfer of soils could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons could enter a watercourse, either directly (during equipment fording) or through run-off from accidental release of fuel or lubricants near a watercourse
Employment / presence of workers	—
Contracting / expenditures	
System commissioning	

Table 13.2.3-3 Potential Project Interactions: Freshwater Resources (continued)

Project Phase / Activity	Key Indicator: Water Quality
Operations and Maintenance	
Maintenance of access trails, roads and stream crossings (e.g., clearing of vegetation from existing permitted fording locations, if required)	– Vegetation removal or disturbance and resulting soil exposure could result in erosion, leading to an increase in nutrients and particulate matter in the water column – Fording of equipment and personnel could cause suspension of silt and particulate matter in the water column – Maintenance of stream crossings may result in increased particulate matter entering a watercourse – Rutting and tracking resulting in exposure or transfer of soils could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons could enter a watercourse, either directly (during equipment fording) or through runoff from accidental release of fuel or lubricants near a watercourse
Presence and operation of the transmission system	—
Routine line inspections and repairs; includes fording	– Vegetation removal or disturbance and resulting soil exposure could result in erosion, leading to an increase in nutrients and particulate matter in the water column – Fording of equipment and personnel could cause suspension of silt and particulate matter in the water column – Rutting and tracking resulting in exposure or transfer of soils could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons could enter a watercourse, either directly (during equipment fording) or through runoff from accidental release of fuel and / or lubricants near a watercourse
Vegetation management (i.e., spraying); includes fording	– Vegetation removal or disturbance and resulting soil exposure could result in erosion, leading to an increase in nutrients and particulate matter in the water column – Fording of equipment and personnel could cause suspension of silt and particulate matter in the water column – Rutting and tracking resulting in exposure or transfer of soils could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons could enter a watercourse, either directly (during equipment fording) or through runoff from accidental release of fuel or lubricants near a watercourse – Run-off, overspray or spills or leaks during spraying or fording could result in herbicides entering a watercourse

Table 13.2.3-3 Potential Project Interactions: Freshwater Resources (continued)

Project Phase / Activity	Key Indicator
	Water Quality
Potential major system repairs; includes fording	– Vegetation removal or disturbance and resulting soil exposure could result in erosion, leading to an increase in nutrients and particulate matter in the water column – Fording of equipment and personnel could cause suspension of silt and particulate matter in the water column – Rutting and tracking resulting in exposure or transfer of soils could result in particulate matter entering a watercourse – Spills or leaks of hydrocarbons could enter a watercourse, either directly (during equipment fording) or through runoff from accidental release of fuel or lubricants near a watercourse
Operation of the electrodes	—
Employment / presence of workers	
Contracting / expenditures	

— No likely or detectable interaction identified with mitigation implemented.

13.2.4 Approach to the Environmental Effects Analysis

13.2.4.1 Analytical Methods

Project effects (e.g., generation of sediment in the watercourse during fording) were predicted by considering the baseline conditions, available CCME PAL guidelines (CCME 2002) and GCDWQ (Health Canada 2010), and the Project mitigation measures that will be employed. A description of how baseline conditions were obtained and a summary of Project mitigation measures are provided below. The difference between baseline water quality parameter values and those values predicted as resulting from the Project was considered to be the effect.

The data used for the description of baseline conditions for the Freshwater Resources within and adjacent to the transmission corridor included:

- channel and instream surveys, including collection of water samples for analysis; and
- use of water sampling and monitoring data from relevant watercourses conducted by secondary sources (i.e., provincial and federal government monitoring water stations and drinking water supplies, including CANAL (Environment Canada 2007, internet site)).

The data collected are summarized in the *Labrador – Island Transmission Link Freshwater Environment: Fish and Fish Habitat, Water Resources Revised Component Study* (AMEC 2010).

Baseline water quality data were summarized by parameters common to all sources, which allowed comparison between sites and regions. This summary of baseline conditions was examined for sites with existing high levels of select parameters and assessment of trends in each region. Presence of water resources with baseline general chemistry and metals concentrations exceeding CCME PAL (CCME 2002) and / or GCDWQ (Health Canada 2010) guidelines may indicate that these conditions are natural and typical of the province's Freshwater Resources, and demonstrates the resilience and adaptability of the organisms that utilize this resource. Exceedances of hydrocarbon guideline values likely indicate contamination resulting from projects and / or activities undertaken prior to the Project, but may also result from natural sources.

The effects on Water Quality were assessed qualitatively by experienced professionals by comparing predicted effects on Water Quality resulting from the Project (i.e., changes in water quality parameters) with CCME PAL (CCME 2002) and GCDWQ guidelines (Health Canada 2010). Mitigation is an integral element of the Project design and implementation. Therefore, the effects assessment is based on the Project with identified mitigation in place.

13.2.4.2 Environmental Effects Descriptors

Table 13.2.4-1 outlines and describes the effects descriptors used in the effects assessment of Freshwater Resources. Each descriptor was estimated and applied to each potential interaction with the KI, with the proposed mitigation in place.

Table 13.2.4-1 Effects Descriptors: Freshwater Resources

Effects Descriptor	Definition
Direction	
Adverse	Reduced Water Quality negatively affecting productive capacity of aquatic life within a watercourse or quality of drinking water (where applicable)
Neutral	No change in Water Quality relative to baseline conditions
Positive	Improvement in Water Quality positively affecting productive capacity of aquatic life within a watercourse or quality of drinking water (where applicable)
Magnitude	
No effect	Effect does not occur (no change in MP from baseline conditions)
Low	Effect on the MP is only nominally above baseline conditions, and within the normal range of variability
Moderate	Effect on the MP exceeds baseline conditions but is less than regulatory criteria or published guideline values, or for MPs which exceed guideline values under baseline conditions, change in MP is less than 10 percent (%) higher than baseline
High	Effect on the MP exceeds regulatory criteria or published guideline values, or for MPs which exceed guideline values under baseline conditions, change in MP is greater than 10% higher than baseline
Geographic Extent	
Local	Effect will be limited to the LSA
Regional	Effect will be limited to the RSA
Beyond regional	Effect extends beyond the RSA
Duration	
Short-term	Effect will be evident for less than one year
Medium-term	Effect will be evident for between one and four years (usually associated with Construction phase)
Long-term	Effect will be evident for longer than four years, but does not extend more than 30 years (this is intended to cover effects of activities related to Construction where the effect will be reversed when a site is reclaimed after construction)
Far-future	Effect will be evident throughout the Project Operations and Maintenance phase
Frequency	
Once	Effect is considered likely to be a one-time event
Infrequent	Effect is considered likely to occur a few times per year (e.g., during high flow events)
Frequent	Effect is considered likely to occur more than a few times per year

13.2.5 Construction

13.2.5.1 Overview of Project Construction and Associated Effects Management

Nalcor has Environmental Policy and Guiding Principles that are designed to maintain a high standard for environmental responsibility and performance through the implementation of a comprehensive environmental management system. Following the guiding principles of 'Preventing Pollution', 'Improve Continually' and 'Comply with Legislation', Nalcor is committed to preventing / avoiding and reducing adverse environmental effects to the extent practical.

Construction phase activities have the potential to affect Water Quality, specifically the levels of TSS, hydrocarbons and nutrients within watercourses or waterbodies. The following describes the activities associated with these effects, and provides a list of mitigations to minimize the effects.

Construction activities associated with stream crossings, including fording, temporary and permanent stream crossings (including culverts and bridges), and ground disturbance near watercourses may introduce suspended solids and nutrients into the water column. Other activities such as construction of access trails and roads, movement and presence of personnel, equipment and materials, ROW clearing and preparation, and conductor installation may also produce similar effects. Removal of rooted vegetation from the ground surface (known as grubbing) exposes soil and organic debris, making it susceptible to water or wind erosion. This action may increase the potential for soil and debris to enter watercourses or waterbodies during high flow conditions (e.g., rainfall or snow melt) or strong wind events, resulting in increased TSS and nutrient levels.

Construction activities such as fording of streams, construction of access trails and roads, ROW clearing and preparation may introduce hydrocarbons into the water column. The presence of equipment in and near a watercourse, and fuelling of equipment, and the storage of fuel within the ROW, may increase the potential for hydrocarbons to enter a watercourse or waterbody.

Standard mitigation measures reduce the likelihood and magnitude of adverse effects. Fisheries and Oceans Canada (DFO) NL Habitat Management Branch fact sheet *Temporary Fording Sites* (DFO 2011, internet site), and the DFO Newfoundland and Labrador Operational Statements (NLOSs) for *Clear Span Bridges* and *Temporary Stream Crossings*, and *Overhead Line Construction* (DFO 2011, internet site) provide recommended mitigation techniques. *Guidelines for Protection for Freshwater Fish Habitat* (Gosse et al. 1998), *Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck et al. 1993) and the *Environmental Guidelines for General Construction Practices* (Water Resources Management Division 1997) also present guidelines and standard practices for mitigating the effects of such activities. Where technically and economically possible, these techniques and standard practices will be adhered to. Such measures include:

- Bridges or culverts will be installed on larger and / or steeper-banked watercourses, where possible and will be sized and installed appropriately.
- Crossings will be restricted to a single location and cross at right angles to the waterbody where possible.
- Disturbance within the waterbody will be limited by minimizing the number of crossings.
- Where possible, crossing locations (including fording, culverts and bridges) will be chosen where the banks and substrate are not sensitive to erosion. If a crossing must occur where the banks of the watercourse or waterbody are sensitive to erosion, the bank will be modified to minimize the potential for erosion. This will include directing natural drainage around areas of disturbed soil and erosion control techniques (i.e., riprap, filter fabric, and placement of gravel or wood chips) and / or revegetation, as appropriate.
- To the extent practical, Construction activities in waterbodies or watercourses will be scheduled to occur during low flow or frozen conditions, to avoid sensitive periods / habitat for fish, and will be shut down during heavy precipitation events.
- Sediment traps / siltation control structures (i.e., silt curtains, sediment fences) and drainage collectors will be installed and maintained at appropriate locations.

- A temporary timber bridge will be installed where practical to minimize siltation of watercourses or waterbodies.
- Equipment will be inspected to confirm it is in proper working order prior to each ford.
- Fuelling of mobile equipment will not be permitted within 50 m of a watercourse or waterbody.
- A spill kit and trained personnel will be present on-site at all times, allowing for prompt containment.
- Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

Further to this list of proposed mitigation, several construction activities are regulated by provincial and federal departments. These activities include fording, which is regulated under Section 48 of the *Water Resources Act* SNL 2002 and Section 35 of the *Fisheries Act*. A permit to ford will be obtained from the appropriate regulators for each watercourse crossing. Any construction activity in or near water is also regulated as per Section 48 of the *Water Resources Act* SNL 2002 c.14-0, Sections 34, 35 and 36 of the *Fisheries Act* and under the *Navigable Waters Protection Act*. Permits will be obtained for all construction that is located within 15 m of the high water mark of a waterbody. Storage and handling of fuels and hazardous or controlled products will be in compliance with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations under the *NLEPA.* All discharges of run-off from Construction activities will conform to the *Environmental Control Water and Sewage Regulations*, 2003 under the *Water Resources Act* (O.C. 2003-231).

Nalcor will conduct the appropriate site evaluations during the final routing of the Project so that, to the extent practical, the selected crossing locations will have the least possible adverse effects on the watercourse. Once the crossing locations are identified, the morphology of the stream at the crossing location will be examined and reported, as per the requirements of the regulatory authorities. Information collected and reported will include the substrate, water velocity, depth and bank slope, and any other required details.

13.2.5.2 Existing Knowledge

Existing knowledge of construction effects on Freshwater Resources resulting from transmission line construction or other similar projects is outlined in Table 13.2.5-1.

Table 13.2.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Freshwater Resources

Reference	Study / Project Context	Summary of Findings
Carroll (2008)	Effects of forestry access construction on four types of watercourse crossings – steel bridge, pole bridges (pipe with poles), standard culvert, reinforced ford – studied during construction and operational use to determine the influence of stream crossing type on water quality and associated erosion	Ford crossings were found to adversely affect water quality indicators, but showed a decrease in total dissolved solids after installation and prior to harvest. Overall, the steel skidder bridges were generally the best crossing type, but any of the crossings can be used effectively with minimal effect under specific site conditions and with judicious installation, use and closure. Road / skid trail location and adherence to existing road grade, water control, cover, and closure best management practices are critical for protection of water quality at stream crossings.
McCarthy (1996)	Effects of access construction and forest harvesting on water quality	Study indicated that improper road construction and mitigations can severely affect water quality in terms of TSS.

13.2.5.3 Construction Effects: Water Quality

Based on professional experience, and considering the mitigation that Nalcor is proposing to use during Construction, it is likely that the amount of soil allowed to enter any given watercourse or waterbody, and the amount of disturbance within a given watercourse or waterbody, will be minimal and there is a low likelihood for release of hydrocarbons.

Increased levels of TSS relative to baseline conditions are expected during activities involving stream fording of equipment. Crossing equipment will re-suspend fine material from the stream substrate with its tracks and / or wheels. This effect is expected to be limited to the construction period because each piece of equipment will complete the crossing quickly, typically in a matter of minutes depending on the size of the watercourse crossing. Sediments will resettle downstream of the fording site.

Increased levels of TSS relative to baseline conditions are expected during activities involving the construction of stream crossings such as bridges and culverts. Installation of such crossings may result in increased potential for particulate matter to enter watercourses. This effect is likely to be limited to the period while each crossing is being constructed. Sediments will settle quickly, downstream of the crossing location.

Increased levels of TSS and nutrient levels relative to baseline conditions are likely following vegetation removal activities and ground disturbance on or near waterbodies. Removing vegetation exposes soil and organic debris, making it susceptible to water or wind erosion, increasing the potential for soil and debris to enter watercourses. Similarly, disturbed soil is more susceptible to erosion, increasing the potential for particulate matter to enter watercourses. These effects are likely to be limited to the Construction period because the mitigation employed during the Project will include effective erosion control measures that will minimize the amount of sediment and nutrient-laden water entering the watercourse. Sediment and debris will resettle downstream of the area disturbed.

Accidents and malfunctions could occur during Construction, as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, multiple tower failure, slope failure) on Water Quality may result in the introduction of material (e.g., soil, organic debris) into a watercourse or waterbody. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be small in scale, the proposed mitigation will likely minimize the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants, which will be addressed quickly.

There is a potential for increased levels of toluene or ethylbenzene relative to the baseline condition due to inadvertently spilled or leaked hydrocarbons during any Project activity conducted on or near a waterbody. A spill or leak from equipment as it crosses a stream would likely be small (to be missed by pre-fording inspections). This effect is likely to be limited because equipment will be in good operating condition, free of leaks, and will be visually inspected for leaks prior to the ford. In addition, a spill kit and trained personnel will be present on-site at all times, allowing for prompt containment.

Summary of Likely Residual Environmental Effects

The likely residual effects of the Project construction on Water Quality are as follows:

- Adverse, because there will be a decrease in Water Quality during fording events, and potentially due to construction activities occurring near watercourses or waterbodies such as the installation of stream crossings;
- Of low magnitude because the suspension of fine material or a leak from equipment during fording is unlikely to be in quantities that would negatively affect Water Quality relative to baseline conditions or exceed CCME guidelines;

- Limited to the RSA; the effect will occur within the LSA, but the suspended particulate matter will resettle as it moves downstream (i.e., potentially into the RSA), and any hydrocarbons released will be addressed immediately thereby limiting the distance of downstream migration; and
- Of short-term duration because particulate matter will settle within minutes to hours after suspension into the water column and any spills and / or leaks will be addressed immediately.

There is a high degree of confidence that the level of effect will not be greater than predicted because effects of these types of Project activities on Water Quality are well understood, and allowed under the appropriate permits. In addition, Nalcor's commitment to, and experience with, applying proven and accepted mitigation measures to Construction activities near Freshwater Resources adds confidence to the prediction.

13.2.6 Operations and Maintenance

13.2.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

Project Operations and Maintenance activities which may have the potential to affect Water Quality may occur during inspections (i.e., those conducted from the ground), and repair and maintenance of towers and stations. The Project interactions and the resulting effects on Water Quality are similar to those described above for the Construction phase, and are related to physical disturbance of watercourses during inspection and /or repairs and vegetation management. The primary difference is that any crossing locations required for maintenance will become increasingly established over time so that they become relatively stabilized. In this way, the effects will be reduced. Effects are expected to occur during inspections and / or repairs, which will be conducted infrequently throughout the Operations and Maintenance phase. As during Construction, mitigation measures relevant to these activities will be followed to minimize effects on Water Quality.

Vegetation management will require the application of an herbicide (i.e., Tordon 101 with Sylgard 309 as a surfactant). All vegetation management activities will be subject to approval from the NLDEC and will be in compliance with the Pesticides Control Regulations under the *Newfoundland and Labrador Environmental Protection Act* (*NLEPA*). In addition to the NLOSs stated above, DFO issued a NLOS on *Maintenance of Riparian Vegetation in Existing Rights of Way* (DFO 2011, internet site) which will be adhered to where possible and practical. Maintenance frequency is anticipated to be low. For example, vegetation management will commence in year eight of operations and be repeated every seven years thereafter, or as required for safety. Standard practice includes public notification and an evaluation of any environmental sensitivity in areas of herbicide use. All herbicide will be applied by qualified, trained personnel in a careful manner, following the manufacturers' instructions and in accordance with the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002. Vegetation control personnel will be appropriately trained and qualified, and vegetation management activities will be designed in accordance with applicable industry and regulatory standards.

Potential for accidents and malfunctions (e.g., hydrocarbon spills or leaks from equipment) during Operations and Maintenance activities conducted near Freshwater Resources will be reduced by ensuring that all equipment is in good operating condition, free of leaks, and will be visually inspected for leaks prior to the ford. Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. In addition, a spill kit and trained personnel will be present on-site at all times, allowing for prompt containment.

Again, further to the list of proposed mitigation, fording activities are regulated under Section 48 of the *Water Resources Act* SNL 2002 and Section 35 of the *Fisheries Act*. A permit to ford will be obtained from the appropriate regulators for each watercourse crossing. If a construction activity is required during Maintenance and Operations, within or near water, it is also regulated as per Section 48 of the *Water Resources Act* SNL 2002 c.14-0, Sections 34, 35 and 36 of the *Fisheries Act* and under the *Navigable Waters Protection Act*. Storage and handling of fuels and hazardous or controlled products will be in compliance with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations under the *NLEPA.* All discharges of run-off from activities will conform to the Environmental Control Water and Sewage Regulations, 2003 under the *Water Resources Act* (O.C. 2003-231).

13.2.6.2 Existing Knowledge

Existing knowledge of effects on Freshwater Resources resulting from Operations and Maintenance of transmission lines or other similar projects is outlined in Table 13.2.6-1.

Routine maintenance of transmission lines is conducted by Nalcor each year. Annually, select transmission line ROWs are travelled and vegetation is controlled (manually and / or chemically). Stream crossings are routine and permitted, with standard mitigation employed.

Table 13.2.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Freshwater Resources

Reference	Study / Project Context	Summary of Findings
Carroll (2008)	Effects of forestry access construction on four types of watercourse crossings – steel bridge, pole bridges (pipe with poles), standard culvert, reinforced ford – studied during construction and operational use to determine the influence of stream crossing type on water quality and associated evaluate erosion	– Ford crossings were found to adversely affect water quality indicators, but showed a decrease in total dissolved solids after installation and prior to harvest. Overall, the steel skidder bridges were generally the best crossing type, but any of the crossings can be used effectively with minimal effect under specific site conditions and with judicious installation, use and closure. Road / skid trail location and adherence to existing road grade, water control, cover, and closure best management practices are critical for protection of water quality at stream crossings.
Jackson et al. (1994)	Herbicide application, new access roads and maintenance in relation to transmission lines	– Non-target aquatic ecosystems may be adversely affected by herbicides used for vegetation control in the right-of-way. – Indirect ecological effects (e.g., increased fishing) may result from construction of access roads and new right-of-way that provides the public easier access to previously remote areas.
Vølstad et al. (2003)	Analysis to determine how the biotic integrity of streams at a local scale is affected by cumulative effects resulting from catchment land uses, point sources, and nearby transmission line rights-of-way	– Vegetation management regimes could reduce the effectiveness of riparian buffers which, in turn, can influence conditions within adjacent streams. The loss of riparian vegetation allows sediment, nutrients, and other contaminants transported by runoff to enter the stream system. The addition of these materials can stress aquatic organisms by reducing dissolved oxygen, changing pH, altering nutrient spiraling pathways, reducing visibility, and physically damaging organisms through abrasion.

13.2.6.3 Operations and Maintenance Effects: Water Quality

Increased levels of TSS relative to baseline conditions are expected during activities involving stream fording of equipment. Crossing equipment will re-suspend fine material from the stream substrate with its tracks and / or wheels. This effect will likely be limited to the inspection or repair period because each piece of equipment will complete the crossing quickly, typically in a matter of minutes depending on the size of the watercourse crossing. Sediments will resettle downstream of the fording site.

Maintenance to existing roads and trails and stream crossings could result in an increase in particulate matter entering a watercourse. These events will likely be limited in frequency and duration, and likely to be of low magnitude. Sediment inputs will settle quickly, downstream of the input location.

Vegetation management and the application of herbicides will be conducted as per the applicable industry and regulatory standards; therefore, no effects on Water Quality are likely to occur as a result of vegetation management.

There is a potential for increased levels of toluene or ethylbenzene relative to the baseline condition due to inadvertently spilled or leaked hydrocarbons during any Project activity conducted on or near a waterbody. A spill or leak from equipment as it crosses a stream would likely be small (to be missed by pre-fording inspections). This effect will likely be negligible because equipment will be in good operating condition, free of leaks, and will be visually inspected for leaks prior to the ford. In addition, a spill kit and trained personnel will be present on-site at all times, allowing for prompt containment.

Accidents and malfunctions could occur during Operations and Maintenance as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, multiple tower failure, slope failure) on Water Quality may result in the introduction of material (e.g., soil, organic debris) into a watercourse or waterbody. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be small in scale, the proposed mitigation will likely minimize the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants or herbicide which will be addressed quickly. A spill kit and trained personnel will be present on-site at all times, allowing for prompt containment, and refuelling will not be permitted within 50 m of a watercourse or waterbody, and fuel storage will be limited.

Summary of Likely Residual Environmental Effects

The likely residual effects of the Project Operations and Maintenance on Water Quality are as follows:

- Adverse, because there will be a decrease in Water Quality during fording events, and potentially due to Operations and Maintenance activities occurring near watercourses or waterbodies.
- Of low magnitude because the suspension of fine material or a leak from equipment during fording is unlikely to be in quantities that would negatively affect Water Quality relative to baseline or exceed CCME guidelines. Herbicides are not likely to enter waterbodies or watercourses.
- Limited to the RSA; the effect will occur within the LSA, but the suspended particulate matter will resettle as it moves downstream (i.e., potentially into the RSA), and any hydrocarbons released will be addressed immediately thereby limiting the distance of downstream migration.
- Of short-term duration because particulate matter will settle within minutes to hours after suspension into the water column and any spills and / or leaks will be addressed immediately.

There is a high degree of confidence that the level of effect will not be greater than predicted because potential effects of these types of Project activities on Water Quality are well understood and allowed under the appropriate permits. In addition, Nalcor's commitment to, and experience in, applying proven and accepted mitigation measures to Operations and Maintenance activities near Freshwater Resources adds confidence to the prediction.

13.2.7 Environmental Effects Summary and Evaluation of Significance

13.2.7.1 Summary of Environmental Effects

As discussed in Section 13.2.4, environmental effects must be assessed in terms of their direction (adverse or beneficial), magnitude, spatial and temporal extent, duration and frequency of occurrence. A summary of the environmental effects analysis for Freshwater Resources is presented Table 13.2.7-1.

13.2.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level.

A Project effect on Freshwater Resources would be deemed significant if it causes a decrease in the Water Quality of a given watercourse, such that applicable guidelines are exceeded, or the watercourse cannot sustain its baseline functions. An environmental effect that does not meet these criteria is not significant.

With the mitigation measures that Nalcor has in place, siltation and disturbance of watercourses will be minimized. Areas of disturbance will be small and localized and occur only where necessary and permitted. Equipment will be in proper working order and where fording a permitted stream is required all precautions will be taken to conduct a clean, efficient crossing. Fording requires a permit which includes information on the stream's morphology at the proposed crossing location. Substrate, water velocity and depth as well as bank slope are among some of the aspects reviewed by provincial authorities prior to granting the fording permit. This pre-examination of the crossing will be undertaken by Nalcor to select the preferred location at each crossing.

Although a substance entering the waterway can have an effect, it is the intensity, duration and magnitude of the effect that determine its significance. Considering that Nalcor is committed to adhering to the relevant legislation and standard mitigation from both industry and government, as well as past experience of Nalcor and the likely Project interactions considered in this assessment, the effects on Freshwater Resources are predicted to be minimal and of short-term duration. Increases in TSS from Project activities will be transient in nature, and any accidental releases of hydrocarbons that may occur will be responded to in a timely manner.

Therefore, any changes to the Water Quality (i.e., increase in TSS, nutrients, herbicidal chemicals, toluene or ethylbenzene in exceedance of guidelines, or relative to baseline for those parameters that exceed guidelines under baseline conditions) that will likely occur as a result of the Project are not expected to affect its baseline functions over the lifetime of the Project. Therefore, the Project is not likely to result in a significant effect on Freshwater Resources.

13.2.8 Evaluation of Project Alternatives

As part of planning and design, alternatives to portions of the transmission corridor have been considered. Freshwater Resources within the alternative corridor segments were evaluated against the Freshwater Resources within the proposed corridor segments through a comparative approach. The results of this comparison are provided in Table 13.2.8-1.

Overall, interactions with Freshwater Resources, regardless of the alternative route, are comparable. However, there was an identified benefit in Alternative A10. Despite the increase in total length of this alternative, it has potential for reducing the number of fords required by using existing infrastructure. The need to disturb the watercourse would be eliminated at crossings where existing culverts or bridges crossing watercourses can be used during the Construction and Operations and Maintenance phases of the Project.

Table 13.2.7-1 Environmental Effects Analysis Summary: Freshwater Resources

<table>
<tr><th rowspan="2">Project Phase / Key Indicator</th><th colspan="5">Likely Residual Environmental Effects Summary Descriptors</th></tr>
<tr><th>Direction</th><th>Magnitude</th><th>Geographic Extent</th><th>Duration</th><th>Frequency</th></tr>
<tr><td colspan="6">Construction</td></tr>
<tr><td>Water Quality</td><td>Adverse
– Particulate matter in the substrate and along the shore will be disturbed and re-suspended during fording and rutting or tracking of soil (increase in TSS)
– Particulate matter may enter a watercourse as a result of the installation of stream crossings (increase in TSS)
– Vegetation removal and grubbing will result in exposed or disturbed soil, leading to an increase in TSS and nutrients, particularly under high flow conditions
– Spills or leaks from any activities conducted on or near watercourses may enter the water, leading to an increase in toluene and ethylbenzene</td><td>Low
– Suspended fine material is unlikely to be in quantities that would negatively affect Water Quality relative to baseline conditions or exceed CCME guidelines
– Quantities of spilled or leaked hydrocarbons will be limited</td><td>Local to Regional
– The disturbance would be at the location of the fording or the stream crossing and suspended particulate matter will resettle as it moves downstream
– Any hydrocarbon release will be contained and recollected as soon as it is noticed with on-site spill kit and trained personnel</td><td>Short-term
– Particulate matter will settle within minutes to hours after suspension into water column
– Any hydrocarbon release will be contained and recollected as soon as it is noticed with on-site spill kit and trained personnel</td><td>– Effects from fording activities and rutting / tracking would occur frequently
– Effects from stream crossing installation would occur once during the construction for each crossing
– Effects from vegetation clearing would occur once</td></tr>
<tr><td colspan="6">Summary of Likely Residual Construction Effects on Freshwater Resources:
Fording activities, stream crossing installation and soil disturbance from vegetation removal and rutting / tracking will introduce materials such as silt or particulate matter, which will increase TSS and nutrient levels. However, the particulate matter will settle to the substrate within the LSA or slightly into the RSA. Spills and / or leaks have the potential to occur within the LSA during activities conducted in or near waterbodies, but effects would be contained within the RSA. Foreign matter entering the watercourse or waterbody is unlikely to be in quantities that would significantly affect Water Quality relative to baseline conditions or would cause an exceedance of CCME guidelines.</td></tr>
</table>

Table 13.2.7-1 Environmental Effects Analysis Summary: Freshwater Resources (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Operations and Maintenance					
Water Quality	**Adverse** – Particulate matter in the substrate and along the shore will be disturbed and re-suspended during fording and rutting or tracking of soil (increase in TSS) – Particulate matter may enter a watercourse as a result of the maintenance to access roads, trails and stream crossings (increase in TSS) – Vegetation removal (e.g., at permitted fording sites) will result in exposed or disturbed soil, leading to an increase in TSS and nutrients, particularly under high flow conditions – Vegetation management (i.e., spraying) may result in herbicidal chemicals entering the water through overspray, run-off or spills – Spills or leaks from any activities conducted on or near watercourses may enter the water, leading to an increase in toluene and ethylbenzene	**Low** – Suspended fine material is unlikely to be in quantities that would negatively affect Water Quality relative to baseline conditions or exceed CCME guidelines – Introduction of herbicides is unlikely to occur in quantities that would exceed CCME guidelines – Quantities of spilled or leaked hydrocarbons will be limited	**Local to Regional** – Suspended particulate matter will resettle as it moves downstream – Small quantities of herbicides that may enter the watercourse would quickly be diluted downstream – Any hydrocarbon release will be contained and recollected as soon as it is noticed with on-site spill kit and trained personnel	**Short-term** – Particulate matter will settle within minutes to hours after suspension into water column – Small quantities of herbicidal chemicals that may enter the watercourse would quickly be diluted – Any hydrocarbon release will be contained and recollected as soon as it is noticed with on-site spill kit and trained personnel	– Effects from vegetation clearing would occur infrequently – Effects from spraying would occur infrequently – Effects from fording activities and rutting / tracking would occur infrequently – Effects from maintenance to access roads and trails and stream crossings would occur infrequently

Table 13.2.7-1 Environmental Effects Analysis Summary: Freshwater Resources (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Summary of Likely Residual Operations and Maintenance Effects on Freshwater Resources: Similar effects are anticipated during the Operations and Maintenance phase of the Project, but the frequency will be considerably lower. Vegetation management activities (i.e., spraying of herbicides) introduce an additional potential effect. Fording activities, maintenance to access roads and trails and stream crossings, and soil disturbance from vegetation removal and rutting / tracking will introduce materials such as silt or particulate matter which will increase TSS and nutrient levels. However, the particulate matter will settle to the substrate within the LSA or slightly into the RSA. Introduction of herbicides, as well as hydrocarbon spills or leaks, have the potential to occur within the LSA during activities conducted in or near waterbodies, but effects would be contained within the RSA. Foreign matter entering the waterway is unlikely to be in quantities that would significantly affect Water Quality relative to baseline or would cause an exceedance of CCME guidelines.					

Table 13.2.8-1 Summary Evaluation of Project Alternative Means: Freshwater Resources

Project Alternative Means[(a)]	Environmental Implications (Compared to the Proposed Transmission Corridor)[(b)]
	Water Quality
A2: Northwest of Strait of Belle Isle Alternative Segment	No difference
A3: Point Amour Alternative Segment	No difference
A4: Strait of Belle Isle Newfoundland Side Alternative Segment	No difference
A5: Great Northern Peninsula (GNP) Northeast Alternative Segment	No difference
A6: GNP West-central Alternative Segment	No difference
A7: GNP Eastern Long Range Mountain (LRM) Crossing Alternative Segment	No difference
A8: GNP International Appalachian Trail Newfoundland and Labrador Alternative Segment	No difference
A9: Birchy Lake Alternative Segment	No difference
A10: Newfoundland and Labrador Outfitters Association Alternative Segment	Access could be provided by the existing roadway, thereby reducing fording or crossing requirements at many watercourses along the alternative section; although the total length of the route would be greater, the number of fording or crossing locations would likely be reduced
A11: Avalon Alternative Segment	No difference

(a) As identified and described in the EIS Project Rationale and Planning, Chapter 2.
(b) Namely, the proposed Project described in the EIS Project Description, Chapter 3, and assessed in the preceding Environmental Effects Analysis.

13.2.9 Cumulative Environmental Effects

Cumulative effects on Freshwater Resources are the overall effect as a result of the Project's likely residual environmental effects on Freshwater Resources that overlap both temporally and geographically with those of other projects and activities. Other projects and activities with the potential to have residual effects that will act cumulatively with Project effects on Freshwater Resources within the RSA are the commercial forest harvesting activities and maintenance of existing roads, including bridges and culverts (all four land-based regions). These projects would have similar residual effects on Freshwater Resources (Water Quality) by increasing sediment and particulate matter in water by disturbing sediment and stream banks during work in and near watercourses, and by removing vegetation resulting in exposed soil that is susceptible to erosion. A summary of likely cumulative effects on Freshwater Resources from the Project in combination with other projects and activities is presented by region in Table 13.2.9-1.

In general, baseline studies have indicated that the quality of water resources throughout the corridor is typical of elsewhere in the province. Water resources located near highly developed areas with roadways and industrial sites show evidence of hydrocarbons or other volatile organic compounds. This is a result of vehicle use, and commercial and industrial activity (AMEC 2010).

Combined effects on Freshwater Resources from the Project and other likely projects and activities are unlikely to be significant, as significant changes to baseline conditions are not anticipated. Any Project effects will be localized and / or of very short-term duration, and of low magnitude. Due to the similar nature of the effects of forestry and road maintenance activities, the extent, magnitude and duration of their effects are also expected to be small. Project activities will not be static, but for the most part will be moving along the corridor with short-term interaction with the VEC, thereby limiting further disruption to any one area. The frequency of potential combined effects would depend on the activity periods and locations of the future projects in or near water work locations associated with the Project. However, the low frequency of maintenance access along the transmission corridor is not predicted to interact with or measurably increase effects on Freshwater Resources associated with other projects.

Table 13.2.9-1 Cumulative Environmental Effects Summary: Freshwater Resources

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[(a)]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula[(b)]
Current (Baseline) VEC Condition (Reflecting the Effects of Past and Ongoing Projects and Activities)	– Quality of Freshwater Resources is typical of that of the province; in general, Water Quality is good (particularly in undeveloped areas), with natural levels above CCME guidelines for aluminum, cadmium, manganese and lead, as well as low pH	Not applicable	– Quality of Freshwater Resources is typical of that of the province; in general, Water Quality is good (particularly in undeveloped areas), with natural levels above CCME guidelines for aluminum, cadmium, manganese and lead, as well as low pH	– Quality of Freshwater Resources is typical of that of the province; in general, Water Quality is good (particularly in undeveloped areas), with natural levels above CCME guidelines for aluminum, cadmium, manganese and lead, as well as low pH	– Quality of Freshwater Resources is typical of that of the province; in general, Water Quality is good (particularly in undeveloped areas), with natural levels above CCME guidelines for aluminum, cadmium, manganese and lead, as well as low pH – in developed areas, elevated levels of TPH, BTEX and VOCs are observed
Likely Residual Environmental Effects of Labrador-Island Transmission Link (Reflecting Current VEC Condition, As Above)	– Short-term, localized impairment of Water Quality within the RSA (increased levels of TSS and nutrients, potential hydrocarbon spills or leaks)	Not applicable	– Short-term, localized impairment of Water Quality within the RSA (increased levels of TSS and nutrients, potential hydrocarbon spills or leaks)	– Short-term, localized impairment of Water Quality within the RSA (increased levels of TSS and nutrients, potential hydrocarbon spills or leaks)	– Short-term, localized impairment of Water Quality within the RSA (increased levels of TSS and nutrients, potential hydrocarbon spills or leaks)

Table 13.2.9-1 Cumulative Environmental Effects Summary: Freshwater Resources (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula[b]
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter	Not applicable	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter
Cumulative Environmental Effects Summary[c]	**Not Significant** – Effects, such as increases in sediment, resulting from the Project are short-term, and unlikely to overlap temporally and spatially with effects of the other projects	Not applicable	**Not Significant** – Effects, such as increases in sediment resulting from the Project are short-term, and unlikely to overlap temporally and spatially with effects of the other projects	**Not Significant** – Effects, such as increases in sediment resulting from the Project are short-term, and unlikely to overlap temporally and spatially with effects of the other projects	**Not Significant** – Effects, such as increases in sediment resulting from the Project are short-term, and unlikely to overlap temporally and spatially with effects of the other projects

(a) Marine Environment. Applicable to the Marine VECs only.

(b) For the Marine VECs, this area comprises the Island of Newfoundland electrode site only.

(c) Total (cumulative) change from the existing environment. Significance of cumulative effects evaluated using same definitions as for the Project Environmental Effects Analysis.

13.2.10 Monitoring and Follow-up

Regular testing of TSS will be conducted in the LSA during Construction activities, to confirm that the CCME PAL guideline is not exceeded. The guideline for TSS is dependent on the baseline level; in clear flow conditions, a maximum increase of 25 mg/L from background levels is permitted for any 24-h period (or an increase of 5 mg/L from background levels for periods); however, under high flow conditions, a maximum increase of 25 mg/L from background levels is permitted at any time when background levels are between 25 and 250 mg/L, or a maximum increase of within 10% of background levels when background is ≥250 mg/L. Water testing would include collection of water samples prior to work near a waterbody or fording to establish current baseline conditions. Samples would subsequently be collected at regular intervals or at select stages of an activity to determine whether guidelines have been or are likely to be exceeded. Activities would be modified based on the test results to avoid guideline exceedance. If mitigation measures for sediment run-off control are proven to be effective by the results of TSS monitoring, regular testing for nutrients will not be conducted.

Monitoring may be required as a condition of approval for a fording permit, or to confirm compliance with regulations regarding water releases and deleterious substances under the *Fisheries Act* and provincial Water and Sewer regulations. Nalcor will comply with regulatory requirements to monitor Water Quality during the Project. These data would also be entered into Nalcor's International Standards Organization (ISO) documentation.

13.3 Fish and Fish Habitat

13.3.1 Introduction

Healthy and sustainable Fish and Fish Habitat are valued from an ecological, economic, and sustenance point of view. For example, many residents and non-residents participate in recreational activities within freshwater systems (Sections 15.5 Land and Resource Use and 15.7 Tourism for a summary of recreational statistics). Potential interactions between the Project and Fish and Fish Habitat could occur both within the Project footprint and adjacent habitat. Adverse effects on Fish and Fish Habitat could occur during all phases of the Project.

A total of 586 streams are crossed by the transmission corridor throughout four land-based regions within the province (194 streams in Central and Southeastern Labrador, 123 in the Northern Peninsula, 170 in Central and Eastern Newfoundland and 99 in the Avalon Peninsula). The watershed areas of these watercourses range in size from less than 2.6 square kilometres (km^2) to greater than 10,000 km^2 (AMEC 2010). All streams that intersect with the centreline of the transmission corridor have been characterized based on satellite and air photo interpretation and supplemented by field surveys / sampling (AMEC 2010). Dominant habitat types of the field-surveyed watercourses were riffle, steady and run. Baseline studies and literature review identified 24 fish species as occurring within watercourses throughout the Study Area, with the highest diversity of species occurring within Central and Southeastern Labrador (AMEC 2010). The most commonly recorded species during baseline field surveys were brook trout and Atlantic salmon (AMEC 2011; AMEC 2010).

Fish SSCC include the American eel (*NLESA* - Vulnerable; COSEWIC - Special Concern), which inhabit the Freshwater Environment of Newfoundland and Labrador. The American eel has been reported in all regions of the Project except the Avalon Peninsula, but was only captured in the Northern Peninsula during the 2008 field surveys (AMEC 2010). This SSCC is integrally assessed within the Fish and Fish Habitat VEC.

13.3.2 Environmental Assessment Study Areas

13.3.2.1 Spatial Boundaries

The LSA is the area where Project-related components and activities that may affect Fish and Fish Habitat will occur (Figure 13.2.2-1). The LSA includes the freshwater habitat within the 2 kilometre (km) wide transmission corridor while also considering the nature and location of other Project activities and components (e.g., access, sites, camps and storage areas).

The RSA is larger than the LSA as interactions may occur downstream of the LSA boundary, particularly if the final ROW location is physically near the downstream extent of the LSA. Although interactions are only likely to occur downstream of the Project, the “downstream side” may switch from side to side along the ROW; therefore, to be conservative, the RSA encompasses an additional 1 km wide buffer along both sides of the LSA (Figure 13.2.2-1). This is identical to the Freshwater Resources RSA definition, as both VECs are interconnected. For example, increased TSS (as described in the Freshwater Resources section) could increase deposition of silt and potentially affect spawning habitat or incubating eggs, depending on the location and time of year of the disturbance or effect.

13.3.2.2 Temporal Boundaries

Temporal boundaries for this VEC are as defined in the EA Methods chapter (Section 9.3.2), encompassing the Construction phase (period between the start of construction and Project commissioning – approximately four years) and Operations and Maintenance phase (indeterminate period following Project commissioning).

13.3.3 Potential Environmental Issues, Indicators and Interactions

13.3.3.1 Potential Environmental Issues

Table 13.3.3-1 outlines the issues associated with the Project and Fish and Fish Habitat, as identified in the EIS Guidelines and Scoping Document (May 2011); through regulatory, Aboriginal and stakeholder consultation; and by the EIS study team. It is anticipated that the issues will be the same for each of the four land-based regions of the Project corridor; therefore, the regions are not addressed separately.

Disturbance of riparian habitat during access trail or road development, culvert or bridge installation and fording activities can increase erosion of stream bank soils or transportation of fine material from exposed areas into freshwater streams if appropriate erosion control measures are not in place. Vegetation removal can alter the temperature regime of a waterbody if shading is removed. The increased sedimentation can result in damage to Fish and Fish Habitat. Noise or vibration, which can result in disturbance to Fish and Fish Habitat, and accidental contamination (e.g., fuel, lubricants, herbicide) are issues. Improved access to waterbodies and watercourses due to Project infrastructure could increase fishing pressure on probable target species (i.e., Atlantic salmon or brook trout).

Table 13.3.3-1 Identified Issues and Questions: Fish and Fish Habitat

Issue / Question	Nature and Rationale	Specific Considerations
Erosion / Sedimentation	– Soil erosion and its transport through the water column increases its TSS load, which causes permanent damage (gill abrasion) in fish (Gosse et al. 1998). – Suspended sediment increases turbidity, which affects fish by making it harder for them to see their prey, reducing feeding rates and in turn growth rates. – Sediment deposition or sedimentation can smother fish eggs and alevins if occurring during spawning, incubation or hatching periods. – Sediment deposition can decrease fish food sources (i.e., benthic invertebrates) through loss of available habitat in interstitial spaces, and through impaired respiration. – Sedimentation can decrease near-surface groundwater flow through the stream substrate, resulting in warmer water in the summer and increased ice formation in the winter. This can produce a loss of coldwater fish habitat in the summer, lethal ice build-up in the winter, and damaging ice scour at break-up. – Interstitial spaces between larger substrate can become plugged with fine sediment and reduce the available over-wintering habitat for juvenile Atlantic salmon.	– Important all year, but especially during spawning periods and egg development. – Sediment deposition can be particularly severe in areas with low flow, lower water velocities, or low gradients.
Noise and / or vibration	– Disturbance from activities on or near the watercourse will cause temporary disturbance of fish in the affected area.	– Important all year, but especially during spawning periods.
Spills / leaks of fuel or lubricants	– Hydrocarbons carried by run-off or deposited directly into the water contaminates that area of the stream and / or will be carried downstream, affecting fish populations.	– Important all year, but especially during spawning periods. Hydrocarbons settling on suitable spawning substrate would degrade the substrate, making it unusable or smother eggs within the interstitial spaces of the substrate.
Chemical input	– Vegetation within the ROW will be managed by periodic herbicide spraying during the Operations and Maintenance phase; run-off or overspray of herbicides into waterbodies may be toxic to fish and their food sources (e.g., invertebrates), depending on the chemical used. Dead leaves entering waterbodies can consume DO during their decomposition resulting in hypoxia.	– Important all year to the health and sustainability of fish and fish habitat; particularly severe in warm water and low flow conditions, when DO levels tend to be lower.
Vegetation removal	– Creates unstable soil conditions, reduces bank stability, and removes overhang which provides cover for fish. – Removal of vegetative cover can alter the temperature regime of a waterbody. – Can contribute to and increase the potential for sedimentation and eutrophication.	– Important all year to the health and sustainability of fish and fish habitat.
Improved access to watercourses and waterbodies	– Access roads, trails and the ROW can provide improved public access to watercourses and waterbodies not previously accessible. This can increase fishing pressure, on probable target species (i.e., Atlantic salmon or brook trout) to a point where their populations decline.	– Particularly important during the permitted angling season, but also year-round with the threat of poaching.

13.3.3.2 Key Indicators and Measurable Parameters

The potential interaction between the Project and existing Fish and Fish Habitat could affect both fish habitat and the fish populations / species assemblages using the habitat. Therefore, the Fish Habitat KI and Fish Abundance and Species Assemblage KI have been chosen to represent the Fish and Fish Habitat VEC. These KIs help to frame and focus the assessment on the potential environmental issues that were identified in Table 13.3.3-1.

Fish habitat consists of substrate composition, aquatic vegetation and water characteristics (e.g., velocity, water depth and TSS). Sufficient and suitable habitat is vital to sustaining fish populations. Protection of fish habitat is required under the *Fisheries Act*. Fish Abundance and Species Assemblage is a measure of population health, and to some extent, habitat health.

Measurable parameters can be analyzed to determine existing Fish and Fish Habitat conditions, and to detect any changes that occur as a result of the Project. Measurable parameters for the Fish and Fish Habitat KIs are outlined in Table 13.3.3-2.

Table 13.3.3-2 Key Indicators and Associated Measurable Parameters: Fish and Fish Habitat

Key Indicator	Rationale for Key Indicator[a]	Measurable Parameter[b]	Rationale for Measurable Parameter
Fish Habitat	– Sufficient and suitable habitat is vital to sustaining fish populations. Changes to habitat components such as substrate composition, aquatic vegetation, water velocity, water depth and TSS (which is addressed in the Freshwater Resources section) can result in changes to specific habitat types and changes in suitability. Protection of fish habitat is required under the *Fisheries Act*.	– Changes, particularly decreases, in habitat quantity (measurable in square metres (m^2)) and quality (measured as suitability indices[c]).	– Decreases in habitat quantity or quality (e.g., productive capacity) can have a negative effect on the fish populations that can be sustained in a given area.
Fish Abundance and Species Assemblage	– A measure of population health, and to some extent, habitat health.	– Change in fish abundance (biomass in grams per cubic metres (g/m^3)) and species composition.	– Decrease in fish abundance due to increased mortality or changes in habitat use can be directly measured. This parameter includes all Project-related effects such as direct mortality, and changes in food availability and predation pressure. – Changes in species composition can be related to changes in habitat suitability for a given species, or to species-specific changes in predation pressure (e.g., recreationally fished species).

[a] Key Indicator: An aspect or characteristic of the VEC or its environment which, if changed as a result of the Project, may result in an effect on the VEC.

[b] Measurable Parameter: An environmental characteristic which is related to the status of a KI. Project effects to a measurable parameter can be detected and measured.

[c] Suitability Index: a quantified measure of habitat suitability at the local scale, calculated based on field measurement of habitat features such as vegetation type and quantity, canopy cover and substrate characteristics.

13.3.3.3 Potential Project-Fish and Fish Habitat Interactions

The potential Project effects on Fish and Fish Habitat are well understood, with practical and effective mitigation readily known and applicable. With the proposed mitigation in place, potential interactions between the Project and the Fish and Fish Habitat VEC are related specifically to fording activities, stream crossings, vegetation removal, increased access to watercourses from Project infrastructure, and accidental release of hydrocarbons associated with construction and Operations and Maintenance. Project interactions with Fish and Fish Habitat are described in Table 13.3.3-3.

13.3.4 Approach to the Environmental Effects Analysis

13.3.4.1 Analytical Methods

Project effects on Fish and Fish Habitat were predicted by considering the baseline conditions and the standard Project mitigation measures that will be employed. A description of how baseline conditions were obtained and a summary of Project mitigation measures are provided below. The difference between baseline Fish and Fish Habitat conditions and those predicted as resulting from the Project was considered to be the effect.

A stream characterization was completed on all watercourses that intersect with the centreline of the transmission corridor, using air photos and 1:50,000 topographic mapping. This level of habitat assessment is typically conducted for low risk activities where detailed quantification of fish habitat is not necessary, yet delineation of potential habitat is required. This is consistent with the habitat assessment approach outlined in DFO's draft riverine quantification methodology (McCarthy et al. 2007). As detailed in AMEC (2010), spatial imagery and GIS applications were used to identify the watercourses that may be crossed within the corridor, as well as the associated watershed areas that were used to classify the watercourse. Watercourses within the transmission corridor were characterized according to five parameters: flow morphology; dominant substrate type; wetted width; full channel width; and riparian vegetation type. These characteristics are important to the classification of fish habitat required by various life stages of fish. A representative sample of stream types throughout the LSA were field surveyed and sampled (AMEC 2010).

Field surveys and water sampling provided baseline data on additional watercourse characteristics (e.g., water velocity and depth, substrate characteristics, riparian vegetation, full channel width and wetted width), fish species presence, water quality, and benthic invertebrates, some of which are indicator species for stream health. A literature review and analysis was conducted to locate all available information pertaining to fish species presence and fish habitat within watersheds of the LSA (AMEC 2010). This review was then compared to species caught during the field program to develop a comprehensive list of fish species, and associated watercourses that could be affected by the Project.

The above data and information defined the baseline conditions with respect to fish habitat availability and fish species present. The data and information were used to determine the types and amounts of fish habitat potentially affected by the Project. The Project mitigation for activities in or near watercourses (summarized in Sections 13.2.5 and 13.2.6) was considered. As well, fisheries-specific mitigation such as activity restriction periods and restricting access of anglers and poachers to previously inaccessible fishing areas by temporary decommissioning of roads, installation of gates and strategic boulder placements for critical areas where important salmon and trout populations will be vulnerable were considered.

A qualitative assessment using professional judgement of experienced fisheries biologists was undertaken to determine the likely effects (e.g., siltation during fording) resulting from the Project. Mitigation is an integral element of the Project design and implementation. Therefore, the effects assessment is based on the Project with identified mitigation in place.

Table 13.3.3-3 Potential Project Interactions: Fish and Fish Habitat

Project Phase / Activity	Key Indicator	
	Fish Habitat	**Fish Abundance and Species Assemblage**
Construction		
Construction of access trails and roads; does not include fording, but includes preparation of fording location	– Installation of instream or near stream structures such as bridges and culverts will result in alteration of habitat types from physical disturbance – Vegetation removal or disturbance and resulting soil exposure could be detrimental to fish habitat by reducing bank stability and instream cover, and increasing TSS and nutrient levels – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat	– Noise and vibration from activities in and near the watercourse may cause fish to move from the area, reducing fish abundance – Vegetation removal or disturbance, rutting, tracking and soil handling will result in an increase in TSS, which can be harmful to fish – Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas – Access trails and roads improve public accessibility to watercourses, potentially leading to reduced abundance of recreationally fished species in some locations – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to fish.
Movement and presence of personnel, equipment and materials (includes fording)	– Stream fording could reduce bank stability, increase suspended sediment and disrupt habitat – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat	– Noise and vibration from activities in and near the watercourse may cause fish to move from the area, reducing fish abundance – Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas – Young fish may not move beyond their established territories, resulting in possible mortalities from crushing as the stream is forded – Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to resident fish populations
Construction camps	– Vegetation removal during clearing of camp site, and resulting soil exposure, could increase TSS and nutrient levels	– Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas – Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations

Table 13.3.3-3 Potential Project Interactions: Fish and Fish Habitat (continued)

Project Phase / Activity	Key Indicator	
	Fish Habitat	**Fish Abundance and Species Assemblage**
Marshalling yards and staging areas	– Vegetation removal during clearing of marshalling yards, and resulting soil exposure, could increase TSS and nutrient levels	– Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas – Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations
Right of way clearing and preparation	– Loss of vegetation could affect bank stability, soil erosion, and increase run-off (leading to increased TSS and nutrient levels) and could reduce overhead cover for fish – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat	– Noise and vibration from activities in and near the watercourse may cause fish to move from the area, reducing fish abundance – Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas – Access trails and roads improve public accessibility of watercourses, potentially leading to reduced abundance of recreationally fished species in some locations
Quarrying and borrowing	—	—
Transmission tower assembly and installation	– Stream fording could reduce bank stability, increase suspended sediment and disrupt habitat – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat	– Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas – Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations – Young fish may not move beyond their established territories, resulting in possible mortalities from crushing as the stream is forded – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to resident fish populations
Conductor installation		
Converter station site preparation and construction	—	—
Preparation and construction of submarine cable landing sites (on-land works)		

Table 13.3.3-3 Potential Project Interactions: Fish and Fish Habitat (continued)

<table>
<tr><th rowspan="2">Project
Phase / Activity</th><th colspan="2">Key Indicator</th></tr>
<tr><th>Fish Habitat</th><th>Fish Abundance and Species Assemblage</th></tr>
<tr><td>Construction and installation of submarine cables (Marine works)</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Electrode site preparation and installation</td></tr>
<tr><td>Island system upgrades</td><td>– Stream fording could reduce bank stability, increase suspended sediment and disrupt habitat
– Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat</td><td>– Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas
– Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations
– Young fish may not move beyond their established territories, resulting in possible mortalities from crushing as the stream is forded
– Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to resident fish populations</td></tr>
<tr><td>Employment / presence of workers</td><td rowspan="3">—</td><td rowspan="3">—</td></tr>
<tr><td>Contracting / expenditures</td></tr>
<tr><td>System commissioning</td></tr>
</table>

Table 13.3.3-3 Potential Project Interactions: Fish and Fish Habitat (continued)

Project Phase / Activity	Key Indicator	
	Fish Habitat	**Fish Abundance and Species Assemblage**
Operations and Maintenance		
Maintenance of access trails and roads (e.g., clearing of vegetation from existing permitted fording locations, if required)	– Vegetation removal / disturbance and resulting soil exposure could be detrimental to fish habitat by reducing bank stability and instream cover, and increasing TSS and nutrient levels – Stream fording could reduce bank stability, increase sedimentation and disrupt substrate – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat	– Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas – Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations – Young fish may not move beyond their established territories, resulting in possible mortalities from crushing as the stream is forded – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to resident fish populations
Presence and operation of the transmission system	—	– Towers located near a stream may be used as perches or nesting sites by birds of prey (e.g., osprey), increasing predation pressure and potentially reducing fish abundance
Routine line inspections and repairs; includes fording	– Loss of vegetation could affect bank stability, soil erosion, and increase run-off and could reduce cover – Stream fording could reduce bank stability, increase sedimentation and disrupt substrate – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat	– Noise and vibration from activities in and near the watercourse may cause fish to move from the area, reducing fish abundance – Young fish may not move beyond their established territories, resulting in possible mortalities from crushing as the stream is forded – Access trails and roads improve public accessibility of watercourses, potentially leading to reduced abundance of recreationally fished species in some locations – Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to resident fish populations

Table 13.3.3-3 Potential Project Interactions: Fish and Fish Habitat (continued)

<table>
<tr><th rowspan="2">Project
Phase / Activity</th><th colspan="2">Key Indicator</th></tr>
<tr><th>Fish Habitat</th><th>Fish Abundance and Species Assemblage</th></tr>
<tr><td>Vegetation management</td><td>– Loss of vegetation could affect bank stability, soil erosion, and increase run-off and could reduce cover
– Herbicides entering surface water can have direct (toxic) and indirect (DO depletion) effects on fish habitat
– Stream fording could reduce bank stability, increase suspended sediment and disrupt habitat
– Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat</td><td>– Herbicides entering surface water can have direct (toxic) and indirect (DO depletion) effects on fish
– Impairment of habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas
– Young fish may not move beyond their established territories, resulting in possible mortalities from crushing as the stream is forded
– Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations
– Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to resident fish populations</td></tr>
<tr><td>Potential major system repairs</td><td>– Loss of vegetation could affect bank stability, soil erosion, and increase run-off and could reduce cover
– Stream fording could reduce bank stability, increase suspended sediment and disrupt habitat
– Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and degrade habitat</td><td>– Young fish may not move beyond their established territories, resulting in possible mortalities from crushing as the stream is forded
– Impairment of water and habitat quality can lead to decrease in fish abundance or change in species assemblage (higher proportion of more hardy species) in affected areas
– Spills or leaks of hydrocarbons (i.e., fuel or lubricants) from equipment could enter a watercourse and cause toxic effects to resident fish populations</td></tr>
<tr><td>Operation of the electrodes</td><td rowspan="3">—</td><td>—</td></tr>
<tr><td>Employment / presence of workers</td><td>– Increased access to watercourses may lead to reduced abundance of recreationally fished species in some locations</td></tr>
<tr><td>Contracting / expenditures</td><td>—</td></tr>
</table>

— No likely or detectable interaction identified.

13.3.4.2 Environmental Effects Descriptors

Table 13.3.4-1 outlines and describes the effects descriptors used in the effects assessment of Fish and Fish Habitat. Each descriptor was estimated and applied to each potential interaction with the KI, with the proposed mitigation in place.

Table 13.3.4-1 Effects Descriptors: Fish and Fish Habitat

Effects Descriptor	Definition
Direction	
Adverse	Net loss of productive capacity of Fish Habitat
Neutral	No net loss of productive capacity of Fish Habitat
Positive	Net increase in the productive capacity of Fish Habitat
Magnitude	
No effect	Effect does not occur
Low	MP is only nominally different from baseline conditions, i.e., within the normal range of variability
Moderate	Effect reduces productive capacity of fish habitat and / or reduces fish abundance, but with the ability to rebound
High	Effect destroys productive capacity of fish habitat and / or reduces fish abundance such that it is incapable of returning to pre-disturbance conditions
Geographic Extent	
Local	Effect will be limited to the LSA
Regional	Effect will be limited to the RSA
Beyond regional	Effect extends beyond the RSA boundary
Duration	
Short-term	Effect will be evident for no more than one day
Medium-term	Effect will be evident for no more than 30 days
Long-term	Effect will be evident for no more than 12 months
Far-future	Effect will be evident throughout Project Operations
Frequency	
Once	Effect is considered likely to be a one-time event
Infrequent	Effect is considered likely to occur a few times per year (e.g., during high flow events)
Frequent	Effect is considered likely to occur more than a few times per year

13.3.5 Construction

13.3.5.1 Overview of Project Construction and Associated Effects Management

During the Construction phase, activities that have the potential to affect Fish and Fish Habitat are those that entail fording or ground disturbance (including vegetation removal) including culvert and bridge installations near or within watercourses. These activities may introduce suspended solids into the water column, impairing fish habitat and possibly leading to a reduction in fish abundance in the affected areas. Fording can also cause direct mortality to young fish that do not leave their established territories. Construction activities can also result in the input of increased nutrients and hydrocarbons, both of which affect the quality of Fish and Fish Habitat within nearby watercourses or waterbodies. The following describes the activities associated with these effects, and provides a list of proposed mitigation to minimize the effects.

Construction activities associated with stream crossings, including fording, temporary and permanent stream crossings (including culverts and bridges), and ground disturbance from riparian vegetation removal near watercourses may introduce suspended solids and nutrients into the water column. Increased TSS may result in an impairment of fish habitat. Other activities such as construction of access trails and roads, movement and presence of personnel, equipment and materials, ROW clearing and preparation, and conductor installation may also produce similar effects. Removal of rooted vegetation from the ground surface (known as grubbing) exposes soil and organic debris, making it susceptible to water or wind erosion. This action may increase the potential for soil and debris to enter watercourses or waterbodies during high flow conditions (e.g., rainfall or snow melt) or strong wind events resulting in increased TSS and nutrient levels.

Construction activities that involve the removal of riparian vegetation during preparation of the ROW, as well as access roads can remove shading for fish habitat; shading helps regulate temperature regimes. This can be particularly important during low flows.

Construction activities such as fording of streams, construction of access trails and roads, ROW clearing and preparation may introduce hydrocarbons into the water column. The presence of equipment in and near a watercourse, and fuelling of equipment, and the storage of fuel within the ROW, may increase the potential for hydrocarbons to enter a watercourse or waterbody.

As well, the ROW will provide access to undeveloped areas, watercourses and open waterbodies, increasing fish mortality through fishing and possibly illegal poaching.

During all Construction activities conducted near fish habitat (e.g., fording and preparation of stream crossing locations), noise and vibration from activities may cause temporary disturbance of fish populations. However, fish will return to the area after the construction crews abandon the sites. In addition, standard mitigation measures during construction will limit the amount of disturbance to local fish populations.

Standard mitigation will be applied by Nalcor to reduce the likelihood and magnitude of adverse effects. DFO NL Habitat Management Branch fact sheet *Temporary Fording Sites* (DFO 2011, internet site) and the DFO NLOSs for *Clear Span Bridges* and *Temporary Stream Crossings*, and *Overhead Line Construction* (DFO 2011, internet site) provide recommended mitigation techniques. Guidelines for Protection for Freshwater Fish Habitat (Gosse et al. 1998), Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1993) and the Environmental Guidelines for General Construction Practices (Water Resources Management Division 1997) also present guidelines and standard practices for mitigating the effects of such activities. Where technically and economically possible, these techniques and standard practices will be adhered to. Such measures include:

- Bridges or culverts will be installed on larger and / or steeper-banked watercourses, where possible and will be sized and installed appropriately.
- Crossings will be restricted to a single location and cross at right angles to the waterbody where possible.
- Disturbance will be limited within the waterbody by minimizing the number of crossings.
- Where possible, crossing locations (including fording, culverts and bridges) will be chosen where the banks and substrate are not sensitive to erosion. If a crossing must occur where the banks of the watercourse or waterbody are sensitive to erosion, the bank will be modified to minimize the potential for erosion. This will include directing natural drainage around areas of disturbed soil and erosion control techniques (i.e., riprap, filter fabric and placement of gravel or wood chips) and / or revegetation, as appropriate.
- To the extent practical, construction activities in waterbodies or watercourses will be scheduled to occur during low flow or frozen conditions, to avoid sensitive periods / habitat for fish, and will be shut down during heavy precipitation events.
- Sediment traps / siltation control structures (i.e., silt curtains, sediment fences) and drainage collectors will be installed and maintained at appropriate locations.
- A temporary timber bridge will be installed where practical to minimize siltation of watercourses or waterbodies.

- Equipment will be inspected to confirm it is in proper working order prior to each ford.
- Fuelling of mobile equipment will not be permitted within 50 m of a watercourse or waterbody.
- A spill kit and trained personnel will be present on-site at all times, allowing for prompt containment.
- Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

Further to this list of proposed mitigation, several construction activities are regulated by provincial and federal departments. These activities include fording which is regulated under Section 48 of the *Water Resources Act* SNL 2002 and Section 35 of the *Fisheries Act*. A permit to ford will be obtained from the appropriate regulators for each watercourse crossing. Any construction activity in or near water is also regulated as per Section 48 of the *Water Resources Act* SNL 2002 c.14-0, Sections 34, 35 and 36 of the *Fisheries Act* and under the *Navigable Waters Protection Act*. Permits will be obtained for all construction that is located within 15 m of the high water mark of a waterbody. Storage and handling of fuels and hazardous or controlled products will be in compliance with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations under the *NLEPA.* All discharges of run-off from construction activities will conform to the Environmental Control Water and Sewage Regulations, 2003 under the *Water Resources Act* (O.C. 2003-231).

Nalcor will conduct the appropriate site evaluations during the final routing of the Project so that, to the extent practical, the selected crossing locations will have the least possible adverse effects on the watercourse, and thus fish and fish habitat. Once the crossing locations are identified, the morphology of the stream at the crossing location will be examined and reported, as per the requirements of the regulatory authorities. Information collected and reported will include the substrate, water velocity, depth and bank slope, and any other required details. In addition, Nalcor will enforce a ‘no-harvesting’ policy for all Project personnel during working hours.

13.3.5.2 Existing Knowledge

Existing knowledge of construction effects on Fish and Fish Habitat resulting from transmission line construction or other similar projects is outlined in Table 13.3.5-1.

Table 13.3.5-1 Existing Knowledge (Construction): Effects of Similar Projects on Fish and Fish Habitat

Reference	Study / Project Context	Summary of Findings
Scruton et al. (1997)	Access roads and stream crossings and vegetation removal	– Suspended sediment within the water column could result in sediment deposition on or within substrate where eggs or alevins are incubating, resulting in their death due to reduced DO levels or fungus proliferation. – Elevated TSS can also clog the gills of fish within the affected area, causing reduced oxygen exchange and reduced feeding efficiency.
Knight (1988); Knight and Bottorff (1984)	Effects of vegetation removal	– Vegetation removal decreases cover over the watercourse, exposing the water to the sun and increasing the water temperature. Removal of vegetation over the watercourse could also expose fish to predation (e.g., birds of prey).
Gibson et al. (1993); Power (1993)	Access roads and stream crossings	– Noise and vibration from machinery and construction activities may cause fish to move away from the section of stream where the disturbance is occurring. Alternatively, younger fish which have an established territory in the stream at a crossing location may not move during the physical crossing, which would cause them to be injured or killed.

13.3.5.3 Construction Effects: Fish Habitat

The fording of equipment can reduce bank stability and re-suspend fine material from the stream substrate with its tracks and / or wheels. Further, vegetation removal and ground disturbance on or near waterbodies including culvert and bridge installations expose soil and organic debris, increasing the potential for particulate matter to enter watercourses. Sediment can re-settle in areas with low flows or lower water velocities, and introduced organic matter can lead to oxygen depletion and hypoxia, negatively affecting Fish Habitat. Sediments will re-settle downstream of the fording site, so the effect would be confined to the RSA, and would be medium to long-term in duration.

Vegetation removal and installation of bridges and culverts will alter physical habitat characteristics at stream crossing locations by changing the amount of available riparian and instream cover and by altering stream bank and stream bed morphology. These effects would be confined to the stream crossing locations within the LSA, and would persist for the length of time that the crossing was required for the Project. Increased water temperature as a result of vegetation removed relative to baseline conditions is not likely during Project construction. Nalcor will include mitigation such as a minimum 20 m buffer on all watercourses, and a reduced ROW of 3 m width at stream crossings; therefore, this effect is not considered further in this assessment.

Accidents and malfunctions could occur during construction as discussed in Chapter 5. The effect of the low-risk incidents (e.g., small brush fire, multiple tower failure, slope failure) on Fish and Fish Habitat may result in the introduction of material (e.g., soil, organic debris) into a watercourse or waterbody. Considering that these events would occur within disturbed areas (e.g., the ROW) and would be limited spatially, the proposed mitigation will likely minimize the effect. The accident most likely to occur is a small spill or leak of fuel or lubricants, which will be addressed quickly.

Potential short-term increased levels of toluene and / or ethylbenzene relative to the baseline condition may occur due to inadvertently spilled or leaked hydrocarbons during any Project activity conducted on or near a waterbody. A spill or leak from equipment as it crosses a stream would most likely be small (to be missed by pre-fording inspections). This effect will be spatially limited to the RSA and temporally limited to the Construction period, because a spill kit and trained personnel would be present on-site at all times, allowing for prompt containment. In addition, dilution of small spills would rapidly reduce or mitigate their effects.

Summary of Likely Residual Environmental Effects

The likely residual effects of the Project construction on Fish Habitat are as follows:

- Adverse, as there will be increase in sedimentation during fording events, installation of stream crossings, and the clearing of riparian vegetation will remove cover and increase the potential for erosion, and there is a potential for the accidental release of hydrocarbons;
- Of low magnitude, as the suspension of fine material or a leak from equipment during fording is not likely to result in a change that will be measurable, but within the normal range of variability;
- Of local to regional geographic extent, as effects are likely to occur at the crossing location (physical habitat changes) and downstream within the RSA (changes to water quality); and
- Of short to far-future duration, as suspended sediments would settle out and accidental hydrocarbon releases would be contained in a matter of hours, the effects of hypoxia would last for months, and the effects of vegetation removal and physical changes to habitat at fording and stream crossings locations would persist for the life of the Project (i.e., far-future duration).

There is a high degree of confidence that the level of effect will not be greater than predicted because potential effects of these types of Project activities on Fish Habitat are well understood, and allowed under the appropriate permits. Nalcor's commitment to, and experience in, applying proven and accepted mitigation measures to Construction activities near freshwater resources adds confidence to the prediction.

13.3.5.4 Construction Effects: Fish Abundance and Species Assemblage

Fording equipment can re-suspend fine material from the stream substrate with its tracks and / or wheels. Further, vegetation removal and ground disturbance on or near waterbodies including during the installation of stream crossings, expose soil and organic debris, increasing the potential for particulate matter to enter watercourses. Suspended sediments are harmful to fish by causing gill damage and affecting their ability to detect prey. Sediments will settle downstream of the fording site and stream crossings, so the effect would be confined to the RSA, and would be short-term in duration.

Vegetation removal and installation of bridges and culverts, as well as substrate compaction due to fording, will alter physical habitat characteristics at stream crossing locations. Vegetation removal may also result in increased organic matter in the water, which may lead to hypoxia. These habitat alterations can, in turn, affect Fish Abundance and Species Assemblages (i.e., the modified habitat may be suitable to different fish species than were found in the baseline condition) in these locations. Physical habitat changes would be confined to the stream crossing locations within the LSA, while hypoxic effects may occur downstream within the RSA; these effects could be temporary (fording) to far-future (bridge installation) in duration.

Improperly installed culverts could negatively affect upstream fish passage, which would remove anadromous or resident migratory species from the upstream fish community. These effects are unlikely to occur, but would be far-future in duration and would affect the upstream reaches of the watercourse (beyond regional).

Stream fording can cause direct fish mortality, as young fish may not move beyond their established territory and can be crushed during fording activity. This effect would be confined to the stream crossing locations within the LSA, and would be short-term in duration, as each piece of equipment will ford a watercourse in a matter of minutes, and population-level effects are unlikely.

Noise and vibration from activities in and near the watercourse will cause fish to move from the area, reducing fish abundance. These effects would be confined to the stream crossing locations within the LSA, and would be of short-term duration, as fish would be expected to return to the area within hours or days after activity has ceased.

Increased accessibility of watercourses due to the establishment of access roads and ROWs will result in increased fishing pressure from the Project personnel and / or the general public. This may lead to reduced abundance of recreationally fished species in some locations, thereby also affecting species assemblages. These effects would likely be confined to the RSA since it is unlikely that fishing activity would be conducted more than 1,000 m from the watercourse crossing, and could last the life of the Project (i.e., far-future duration), depending on the type of access.

Potential short-term increased levels of toluene and / or ethylbenzene relative to the baseline condition may occur due to inadvertently spilled or leaked hydrocarbons during any Project activity conducted on or near a waterbody, which may have toxic effects on resident fish populations. A spill or leak from equipment as it crosses a stream would most likely be small (to be missed by pre-fording inspections). This effect will likely be spatially limited to the RSA and temporally limited to the Construction period, because a spill kit and trained personnel would be present on-site at all times, allowing for prompt containment. In addition, dilution of small spills would rapidly reduce or mitigate their effects.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Fish Abundance and Species Assemblage are as follows:

- Adverse, since Fish Abundance and Species Assemblage may change due to changes in habitat and water quality, temporary scattering of fish in the area, the injury or death of young fish due to crushing as they retreat to their home territory, angling pressure and increased vulnerability to raptors;

- Of low to moderate magnitude, since most effects will result in a change in fish abundance and Species Assemblage that will be evident, but within the normal range of variability; however, increase in access could have an effect on the populations of sport fish species;
- Of local to regional extent, since effects are predicted to occur at the crossing location and downstream within the RSA; and
- Of short-term to far-future duration, since effects due to noise disturbance and suspended sediments would be short-term, the effects of eutrophication would last for months, the effects of vegetation removal, increased predation pressure and physical changes to habitat at fording and stream crossing locations would be of far-future in duration.

There is a high degree of confidence that the level of effect will not be greater than predicted because potential effects of these types of Project activities on Fish Abundance and Species Assemblage are well understood, and allowed under the appropriate permit. In addition, Nalcor's commitment to, and experience in, applying proven and accepted mitigation measures to Construction activities near freshwater resources adds confidence to the prediction.

13.3.6 Operations and Maintenance

13.3.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

Project Operations and Maintenance activities which have the potential to affect Fish and Fish Habitat may occur during inspections (i.e., those conducted from the ground), and repair and maintenance of towers and stations. Approximately 10% of the transmission line will be inspected via ground in any given year, and the entire line will be inspected via helicopter and / or ground. The Project interactions and the resulting effects on Fish and Fish Habitat are similar to those described above for the Construction phase, and are related to physical disturbance of watercourses during inspection and / or repairs and vegetation management. The primary difference is that any crossing locations required for maintenance will become increasingly established over time so that they become relatively stabilized. In this way, the effects will be somewhat reduced. Effects are likely to occur during inspections and / or repairs, which will be conducted infrequently throughout the Operations and Maintenance phase. As during Construction, mitigation measures relevant to fording and crossing maintenance will be followed to minimize effects on Fish and Fish Habitat.

Vegetation management will require the application of a herbicide (i.e., Tordon 101). All vegetation management activities will be subject to approval from the NLDEC and will be in compliance with the Pesticides Control Regulations under the *Newfoundland and Labrador Environmental Protection Act* (*NLEPA*). In addition to the NLOSs stated above, DFO also issues an NLOS on *Maintenance of Riparian Vegetation in Existing Rights of Way* (DFO 2010, internet site) which will be adhered to where possible and practical. Maintenance frequency is anticipated to be low. For example, vegetation management will commence in year eight of operations and be repeated every seven years thereafter, or as required for safety. Standard practice includes public notification and an evaluation of any environmental sensitivities in areas of herbicide use. Vegetation management personnel will be appropriately trained and qualified, and vegetation management activities will be designed and conducted in accordance with applicable industry and regulatory standards.

Potential for accidents and malfunctions (e.g., hydrocarbon spills or leaks from equipment) during Operations and Maintenance activities conducted near freshwater resources will be reduced by ensuring that all equipment is in good operating condition, free of leaks, and will be visually inspected for leaks prior to the ford. Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. In addition, a spill kit and trained personnel will be present on-site at all times, allowing for prompt containment.

As well, the ROW will continue to provide access to undeveloped areas, watercourses and waterbodies, increasing the potential for fish mortality through fishing and possibly poaching. Nalcor will enforce a 'no-harvesting' policy during working hours for all maintenance and repair personnel.

Again, further to the list of proposed mitigation, fording activities are regulated under Section 48 of the *Water Resources Act* SNL 2002 and Section 35 of the *Fisheries Act*. A permit to ford will be obtained from the appropriate regulators for each watercourse crossing. If a construction activity is required during Maintenance and Operations, within or near water, it is also regulated as per Section 48 of the *Water Resources Act* SNL 2002 c.14-0, Sections 34, 35 and 36 of the *Fisheries Act* and under the *Navigable Waters Protection Act*. Storage and handling of fuels and hazardous or controlled products will be in compliance with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations under the *NLEPA.* All discharges of run-off from Construction activities will conform to the Environmental Control Water and Sewage Regulations, 2003 under the *Water Resources Act* (O.C. 2003-231).

13.3.6.2 Existing Knowledge

Existing knowledge of effects on Fish and Fish Habitat resulting from Operations and Maintenance of transmission lines or other similar projects is outlined in Table 13.3.6-1.

Table 13.3.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Fish and Fish Habitat

Reference	Study / Project Context	Summary of Findings
Jackson et al. (1994)	Herbicide application, new access roads and maintenance in relation to transmission lines	– Non-target aquatic ecosystems may be adversely affected by herbicides used for vegetation control in the right-of-way. – Indirect ecological effects (e.g., increased fishing) may result from construction of access roads and new right-of-way that provides the public easier access to previously remote areas. – Aquatic species that are listed as Endangered, Threatened, or Sensitive may be adversely affected by disturbance from transmission line maintenance activities.
Vølstad et al. (2003)	Analysis to determine how the biotic integrity of streams at a local scale is affected by cumulative effects resulting from catchment land uses, point sources, and nearby transmission line rights-of-way	– Vegetation management regimes could reduce the effectiveness of riparian buffers which, in turn, can influence conditions within adjacent streams. The loss of riparian vegetation allows sediment, nutrients, and other contaminants transported by runoff to enter the stream system. The addition of these materials can stress aquatic organisms by reducing dissolved oxygen, changing pH, altering nutrient spiraling pathways, reducing visibility, and physically damaging organisms through abrasion.

13.3.6.3 Operations and Maintenance Effects: Fish Habitat

Fording will result in substrate compaction, which reduces the interstitial spacing between rocks that fish (particularly younger salmonids) occupy. Rutting from heavy machinery can cause water to build up, and can isolate small fish and reroute drainage through rutting channels. These effects would be confined to the LSA, and would be long-term in duration.

Fording equipment will reduce bank stability and re-suspend fine material from the stream substrate with its tracks and / or wheels. Further, vegetation removal and ground disturbance including stream crossings on or near waterbodies exposes soil and organic debris, increasing the potential for particulate matter to enter watercourses. Sediments can re-settle in areas of low tractive force as defined by water slope and depth, and introduced organic matter can lead to oxygen depletion and hypoxia, negatively affecting Fish Habitat.

Sediments will re-settle downstream of the fording site, so the effect would be confined to the RSA, and would be long-term in duration.

Vegetation removal and culvert and bridge maintenance will alter physical habitat characteristics at stream crossing locations by changing the amount of available riparian and instream cover and by altering stream bank and stream bed morphology. These effects would be confined to the LSA, and would be far-future in duration, persisting through the life of the Project.

Potential short-term increased levels of toluene and / or ethylbenzene relative to the baseline condition may occur due to inadvertently spilled or leaked hydrocarbons during any Project activity conducted on or near a waterbody. A spill or leak from equipment as it crosses a stream would most likely be small (to be missed by pre-fording inspections). This effect is likely to be spatially limited to the RSA and temporally limited to the maintenance activity, because a spill kit and trained personnel would be present on-site at all times, allowing for prompt containment. In addition, dilution of small spills would rapidly reduce or mitigate their effects.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on Fish Habitat are as follows:

- Adverse, since there will be increase in sedimentation during fording events and use or maintenance of stream crossings, clearing / disturbance of riparian vegetation will remove cover and increase the potential for erosion, and there is a potential for the accidental release of hydrocarbons;
- Of low magnitude, since effects will result in a change that will be evident, but within the normal range of variability;
- Of local to regional geographic extent, since effects are predicted to occur at the crossing location (physical habitat changes) and downstream within the RSA (changes to water quality); and
- Of short-term to far-future duration, since suspended sediments would settle out and accidental hydrocarbon releases would be contained in a matter of hours, the effects of eutrophication would last for months, and the effects of vegetation removal and physical changes to habitat at fording and stream crossing locations would be far-future in duration.

There is a high degree of confidence that the level of effect will not be greater than predicted because potential effects of these types of Project activities on Fish Habitat are well understood, and allowed under the appropriate permit. Nalcor's commitment to, and experience with applying proven and accepted mitigation measures for Operations and Maintenance activities near freshwater resources adds confidence to the prediction.

13.3.6.4 Operations and Maintenance Effects: Fish Abundance and Species Assemblage

Fording equipment will re-suspend fine material from the stream substrate with its tracks and / or wheels. Further, vegetation removal and ground disturbance on or near waterbodies including the use and maintenance of stream crossings expose soil and organic debris, increasing the potential for particulate matter to enter watercourses. Suspended sediments are harmful to fish by causing gill damage and affecting their ability to detect prey. Sediments will settle downstream of the fording and stream crossing site, so the effect would be confined to the RSA, and would be short-term in duration.

Chemical run-off or overspray during herbicide (i.e., Tordon 101 with Sylgard 309 as a surfactant) application for vegetation management could be toxic to fish or their prey. However, when used properly there will not be sufficient contamination of water to present a risk to aquatic life. Exposure from spraying close to the watercourse may kill vegetation along the bank affecting Fish Abundance and / or Species Assemblage by reducing overhead cover, thereby increasing exposure to predation and rising water temperatures. All herbicide will be applied by qualified, trained personnel in a careful manner, following the manufacturers' instructions and in accordance with the Pesticides Control Regulations 1996 (plus amendments) under the

Environmental Protection Act SNL 2002. Adherence to appropriate application methods will limit the potential for these effects. These effects would be confined to the RSA, and would be short to medium-term in duration.

Vegetation removal and use / maintenance of bridges and culverts, as well as substrate compaction due to fording, will alter physical habitat characteristics at stream crossing locations. Vegetation removal may also result in increased organic matter in the water column, which can lead to oxygen depletion and hypoxia. These habitat alterations can in turn affect Fish Abundance and Species Assemblage (i.e., the modified habitat may be suitable to different fish species than were found in the baseline condition) in these locations. Physical habitat changes would be confined to the stream crossing locations within the LSA, while hypoxic effects may occur downstream within the RSA; these effects would be temporary to far-future in duration.

Stream fording may cause direct fish mortality, as young fish may not move beyond their established territory during fording activity. This effect would be confined to the stream crossing locations within the LSA, and would be short-term in duration, since each piece of equipment will ford a watercourse in a matter of minutes and is therefore unlikely to cause population-level effects.

Towers located near a stream, or stream crossings (i.e., bridges) may provide perches and / or nesting sites for birds of prey, increasing predation pressure and potentially reducing fish abundance. These effects would be confined to the RSA, and would last for the life of the Project (i.e., far-future duration).

Increased accessibility of watercourses due to the establishment of access roads and ROWs may result in increased fishing pressure. This may lead to reduced abundance of recreationally fished species in some locations, thereby affecting both Fish Abundance and Species Assemblage. These effects would likely be confined to the RSA as it is unlikely that fishing activity would be conducted more than 1000 m from the watercourse crossing, and would last for the life of the Project (i.e., far-future duration).

Potential short-term increased levels of toluene and / or ethylbenzene relative to the baseline condition may occur due to inadvertently spilled or leaked hydrocarbons during any Project activity conducted on or near a waterbody, which may have toxic effects on resident fish populations. A spill or leak from equipment as it crosses a stream would most likely be small (to be missed by pre-fording inspections). This effect will likely be to be spatially limited to the RSA and temporally limited to the fording activities, because a spill kit and trained personnel would be present on-site at all times, allowing for prompt containment. In addition, dilution of small spills would rapidly reduce or mitigate their effects.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on Fish Abundance and Species Assemblage are as follows:

- Adverse, since fish abundance or species assemblage may change due to changes in habitat and water quality, temporary scattering of fish in the area, the injury or death of young fish due to crushing as they retreat to their home territory, angling pressure and increased vulnerability to raptors;
- Of low to moderate magnitude, since most effects will result in a change in fish abundance and Species Assemblage that will be evident, but within the normal range of variability; however, increase in access could have an effect on the populations of sport fish species;
- Of local to regional geographic extent, since effects are predicted to occur at the crossing location and downstream within the RSA; and
- Of short-term to far-future duration, since effects due to noise disturbance and suspended sediments would be short-term, the effects of hypoxia could last for months, and the effects of vegetation removal, increased natural predation and angling related mortality of fish as well as physical changes to habitat at fording and stream crossing locations would be far-future in duration.

There is a high degree of confidence that the level of effect will not be greater than predicted because potential effects of these types of Project activities on Fish Abundance and Species Assemblage are well understood, and allowed under the appropriate permit. Nalcor's commitment to, and experience in, applying proven and accepted mitigation measures for Operations and Maintenance activities near freshwater resources adds confidence to the prediction.

13.3.7 Environmental Effects Summary and Evaluation of Significance

13.3.7.1 Summary of Environmental Effects

As discussed in Section 13.3.4, environmental effects must be assessed in terms of their direction (adverse or beneficial), magnitude, spatial and temporal extent, duration and frequency of occurrence. The assessment of significance of an effect considers all these factors. A summary of the environmental effects analysis for Fish and Fish Habitat is presented Table 13.3.7-1.

Table 13.3.7-1 Environmental Effects Analysis Summary: Fish and Fish Habitat

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Fish Habitat	**Adverse** – Instream habitat will be affected during fording events – Clearing of riparian vegetation and culvert and bridge installation will remove cover and increase erosion potential – Potential for accidental release of hydrocarbons	**Low** – Effect will result in a change that will be evident, but within the normal range of variability	**Local to Regional** – Effects are predicted to occur at the crossing location (physical habitat changes) and downstream within the RSA (changes to water quality)	**Short-term to Far-future** – Suspended sediments would settle out quickly – Accidental hydrocarbon releases would be contained in a matter of hours – Effects of hypoxia would last for months – Effects of vegetation removal and physical changes to habitat at fording and stream crossing locations would persist through the life of the Project (i.e., far-future)	**Infrequent** – Effects will occur during Construction activities conducted in or near a stream or waterbody in unfrozen conditions

Table 13.3.7-1 Environmental Effects Analysis Summary: Fish and Fish Habitat (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Fish Abundance and Species Assemblage	**Adverse** – Fish abundance may be affected due to temporary scattering of fish in the area – Abundance or species assemblage may change due to changes in habitat and water quality – Young fish may be injured or killed due to crushing as they retreat to their home territory – Angling pressure is likely to increase in areas previously not as accessible to anglers – Increased vulnerability to raptors – Improperly installed culverts may prevent upstream passage of anadromous or resident migratory fish species	**Low to Moderate** – Most effects will result in a change in Fish Abundance and Species Assemblage that will be evident, but within the normal range of variability – Increase in access could have a moderate effect on the populations of sport fish species	**Local to Regional** – Effects are predicted to occur at the crossing location and downstream within the RSA	**Short-term to Far-future** – Effects due to noise disturbance and suspended sediments would be short-term – Effects of eutrophication would last for months – Effects of vegetation removal, increased predation pressure and physical changes to habitat at fording and stream crossing locations would persist through the life of the Project (i.e., far-future)	**Infrequent** – Effects would occur during construction while activities are near an unfrozen watercourse – Changes in watercourse accessibility would only occur once (construction of ROW)

Summary of Likely Residual Construction Effects on Fish and Fish Habitat:

There is potential for Construction activities to affect Fish Habitat, and Fish Abundance and Species Assemblage. However, with the implementation of the mitigation measures to which Nalcor is committed, these effects will be limited in terms of geographic extent and / or duration. For example, fish disturbance from noise / vibration and increases in suspended sediment and biological oxygen demand levels from Project activities will be transient in nature. Physical changes to Fish Habitat will be localized to only a small section of each watercourse (i.e., at the stream crossing location). Any accidental releases of hydrocarbons that may occur will be responded to in a timely manner. Culverts and bridges will be sized and installed so that upstream fish passage is unimpaired. Access to fishing areas by anglers and poachers is a threat to sport fish populations; barriers to access will be erected at appropriate locations, but these are not expected to be entirely effective. Therefore, effects to the Fish and Fish Habitat VEC during the Construction phase of the Project will be low to moderate in magnitude and not likely to affect populations at the regional scale.

Table 13.3.7-1 Environmental Effects Analysis Summary: Fish and Fish Habitat (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Operations and Maintenance					
Fish Habitat	**Adverse** – Instream habitat will be affected during fording events – Clearing of riparian vegetation and use / maintenance of stream crossings will remove cover and increase erosion potential – Potential for accidental release of hydrocarbons	**Low** – Effects will result in a change that will be evident, but within the normal range of variability	**Local to Regional** – Effects are predicted to occur at the crossing location (physical habitat changes) and downstream within the RSA (changes to water quality)	**Short-term to Far-future** – Suspended sediments would settle out and accidental hydrocarbon releases would be contained in a matter of hours – Effects of eutrophication would last for month – Effects of vegetation removal and physical changes to habitat at fording locations and stream crossings would persist through the life of the Project (i.e., far-future)	**Infrequent** – Effects will occur during Operations and Maintenance activities conducted in or near a stream or waterbody in unfrozen conditions

Table 13.3.7-1 Environmental Effects Analysis Summary: Fish and Fish Habitat (continued)

<table>
<tr><th rowspan="2">Project Phase / Key Indicator</th><th colspan="5">Likely Residual Environmental Effects Summary Descriptors</th></tr>
<tr><th>Direction</th><th>Magnitude</th><th>Geographic Extent</th><th>Duration</th><th>Frequency</th></tr>
<tr><td>Fish Abundance and Species Assemblage</td><td>Adverse
– Fish abundance may be affected due to temporary scattering of fish in the area
– Abundance or species assemblage may change due to changes in habitat and water quality
– Young fish may be injured or killed due to crushing as they retreat to their home territory
– Predation pressure is likely to increase in areas previously not as accessible to anglers and to raptors</td><td>Low to Moderate
– Most effects will result in a change in Fish Abundance and Species Assemblage that will be evident, but within the normal range of variability
– Increase in access could have a moderate effect on the populations of sport fish species</td><td>Local to Regional
– Effects are predicted to occur at the crossing location and downstream within the RSA</td><td>Short-term to Far-future
– Effects due to noise disturbance and suspended sediments would be short-term
– Effects of hypoxia could last for months
– Effects of vegetation removal, increased natural predation and angling related mortality of fish as well as physical changes to habitat at fording locations would persist through the life of the Project (i.e., far-future)</td><td>Infrequent
– Effects would occur during Operations and Maintenance while activities are near an unfrozen watercourse
– Changes in watercourse accessibility would be chronic and occur after construction of the ROW</td></tr>
<tr><td colspan="6">Summary of Likely Residual Operations and Maintenance Effects on Fish and Fish Habitat:
Similar to the Construction phase, there is potential for Operations and Maintenance activities to affect Fish Habitat, and Fish Abundance and Species Assemblage. These effects are similar to those predicted for the construction phase, and again, with the implementation of the mitigation measures to which Nalcor is committed, these effects will be limited in terms of geographic extent and / or duration. For example, fish disturbance from noise / vibration and increases in suspended sediment and biological oxygen demand levels from Project activities will be transient in nature. Further, as fording locations become more established over time, effects of each crossing (e.g., sedimentation of the watercourse and compaction of substrate) will decrease. Physical changes to Fish Habitat will be localized to only a small section of each watercourse (i.e., at the stream crossing location). Any accidental releases of hydrocarbons that may occur will be responded to in a timely manner. Access to fishing areas by anglers and poachers is a threat to sport fish populations; barriers to access will be erected at appropriate locations, but these are not expected to be entirely effective. Therefore, effects to the Fish and Fish Habitat VEC during the Operations and Maintenance phase of the Project is likely to be low to moderate in magnitude and not likely to affect populations at the regional scale.</td></tr>
</table>

13.3.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level.

A significant effect on Fish and Fish Habitat Is one which could alter, disrupt or destroy Fish Habitat and / or affect Fish Abundance and Species Assemblage such that the aquatic environment is unable to recover. An environmental effect that does not meet these criteria is not significant.

Actions can lead to Fish Habitat alteration, disruption or destruction and / or fish mortality through siltation, excess noise and vibration, spills, leaks or increased fishing pressure. However, because the proper mitigation measures will be in place, siltation and disturbance of watercourses will be negligible. Areas of disturbance (e.g., fording and stream crossings) will be limited and occur only where necessary and permitted. Equipment will be in proper working order and where fording a permitted stream is required all precautions will be taken into effect such that a clean, efficient crossing occurs. Fording requires a permit which includes an examination of the stream's morphology at the proposed crossing location. Substrate, water velocity and depth as well as bank slope are some of the aspects reviewed by regulatory authorities prior to granting the fording permit. This pre-examination of the crossing will be undertaken by Nalcor to select the preferred location at each watercourse. Restricting access of anglers and poachers to previously inaccessible fishing areas within the ROW will be accomplished by temporary decommissioning of roads, gates and / or strategic boulder placements for appropriate areas where important salmon and trout populations will be vulnerable; if permanent access along the ROW will not be maintained, then increased angling pressure will not be a long-term issue.

Effective mitigation and proper location of fording and / or stream crossings will minimize disturbance. Fish disturbance from noise and vibration, and increases in suspended sediment and nutrient levels from Project activities will be transient in nature. Changes to physical Fish Habitat will be localized to only a small section of each watercourse (i.e., at the stream crossing location). Any accidental releases of hydrocarbons that may occur will be responded to in a timely manner.

Therefore, changes to Fish and Fish Habitat (i.e., changes in Fish Habitat or Fish Abundance and Species Assemblage such that the Freshwater environment is unable to recover) are not predicted to occur as a result of the Project. In addition, Nalcor is committed to adhere to the associated legislation, NLOSs and standard mitigation from both industry and government where feasible, and any permit conditions. Considering this, the effects to Fish and Fish Habitat are predicted to be not significant.

13.3.8 Evaluation of Project Alternatives

As part of planning and design, alternatives to portions of the proposed transmission corridor have been considered. Fish and Fish Habitat within the alternative corridor segments were evaluated against the Fish and Fish Habitat within the proposed corridor segments through a comparative approach. The results of this comparison are provided in Table 13.3.8-1.

Table 13.3.8-1 Summary Evaluation of Project Alternative Means: Freshwater Fish and Fish Habitat

Project Alternative Means[a]	Environmental Implications (Compared to the Proposed Transmission Corridor)[b]	
	Fish Habitat	Fish Abundance and Species Assemblage
A2: Northwest of Strait of Belle Isle Alternative Segment	No difference	No difference
A3: Point Amour Alternative Segment	No difference	No difference

Table 13.3.8-1 Summary Evaluation of Project Alternatives: Freshwater Fish and Fish Habitat (continued)

Project Alternative Means[a]	Environmental Implications (Compared to the Proposed Transmission Corridor)[b]	
	Fish Habitat	Fish Abundance and Species Assemblage
A4: Strait of Belle Isle Newfoundland Side Alternative Segment	No difference	No difference
A5: GNP Northeast Alternative Segment	No difference	No difference
A6: GNP West-central Alternative Segment	No difference	No difference
A7: GNP Eastern LRM Crossing Alternative Segment	No difference	No difference
A8: GNP IATNL Alternative Segment	No difference	No difference
A9: Birchy Lake Alternative Segment	No difference	No difference
A10: Newfoundland and Labrador Outfitters Association Alternative Segment	Access could be provided by the existing highway, thereby reducing access road, fording and stream crossing requirements, and resulting in fewer disturbances to Fish Habitat at watercourses along the alternative section; although the total length of the route would be greater, the number of fording and /or crossing locations would be reduced	Access could be provided by the existing highway, thereby reducing access road, fording and stream crossing requirements, and resulting in fewer disturbances to fish populations at watercourses along the alternative section; although the total length of the route would be greater, the number of fording and / or crossing locations would be reduced
A11: Avalon Alternative Segment	No difference	No difference

[a] As identified and described in the EIS Project Rationale and Planning, Chapter 2.

[b] Namely, the proposed Project described in the EIS Project Description, Chapter 3, and assessed in the preceding Environmental Effects Analysis.

Overall, interactions with Fish and Fish Habitat, regardless of most of the alternative routes, are comparable. However, there was an identified benefit in Alternative A10. Despite the increase in total length of this alternative, it has potential for reducing the number of access roads, fords and stream crossings required by using existing infrastructure. The need to disturb the watercourse would be eliminated at crossings where existing culverts or bridges crossing watercourses can be used during the Construction, and Operations and Maintenance phases of the proposed Project.

13.3.9 Cumulative Environmental Effects

Cumulative effects on Fish and Fish Habitat are the overall effect as a result of the Project's likely residual environmental effects on Fish and Fish Habitat that overlap both temporally and geographically with those of other projects and activities. Other projects and activities with likely residual effects that will act cumulatively with likely Project effects on Fish and Fish Habitat within the RSA are the forest harvesting activities and maintenance of existing roads, including bridges and culverts (in all four land-based regions). These projects would have similar residual effects on Fish Habitat by increasing sediment and particulate matter in water by disturbing sediment and stream banks during work in and near watercourses, by removing vegetation resulting in exposed soil that is susceptible to erosion and by increasing access. A summary of likely cumulative effects on Fish and Fish Habitat from the Project in combination with other projects and activities is presented by region in Table 13.3.9-1.

Table 13.3.9-1 Cumulative Environmental Effects Summary: Freshwater Fish and Fish Habitat

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula[b]
Current (Baseline) VEC Condition (Reflecting the Effects of Past and Ongoing Projects and Activities)	– Variety of fish habitats with generally good water quality within the transmission corridor – Supports typical fish species assemblage for the region, with greater species variety than the other (insular) regions – One Species of Special Concern (American eel) has been reported, but was not captured in 2008 field surveys (AMEC 2010)	– not applicable	– Variety of fish habitats with generally good water quality within the transmission corridor – Supports typical fish species assemblage for the region – One Species of Special Concern (American eel) was captured in 2008 field surveys (AMEC 2010)	– Variety of fish habitats with generally good water quality within the transmission corridor – Supports typical fish species assemblage for the region – One Species of Special Concern (American eel) has been reported, but was not captured in 2008 field surveys (AMEC 2010)	– Variety of fish habitats with generally good water quality within the transmission corridor (although more elevated levels of TPH, BTEX and VOCs than in the other, less developed regions) – Supports typical fish species assemblage for the region (AMEC 2010)

Table 13.3.9-1 Cumulative Environmental Effects Summary: Freshwater Fish and Fish Habitat (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[(a)]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula[(b)]
Likely Residual Environmental Effects of Labrador-Island Transmission Link (Reflecting Current VEC Condition, As Above)	– Changes to physical habitat (e.g., vegetation removal and substrate compaction) at fording and stream crossing locations within the LSA; suspension of TSS and organic material in the water column and potential spills / leaks of hydrocarbon leading to temporary adverse effects on fish habitat in the RSA at and downstream of fording and stream crossing locations – Increased predation pressure within the RSA due to improved accessibility of watercourses – Disturbance and potential mortality to fish within the LSA during stream fording and activity on / near watercourses	– not applicable	– Changes to physical habitat (e.g., vegetation removal and substrate compaction) at fording and stream crossing locations within the LSA; suspension of TSS and organic material in the water column and potential spills / leaks of hydrocarbon leading to temporary adverse effects on fish habitat in the RSA at and downstream of fording and stream crossing locations – Increased predation pressure within the RSA due to improved accessibility of watercourses – Disturbance and potential mortality to fish within the LSA during stream fording and activity on / near watercourses	– Permanent changes to physical habitat (e.g., vegetation removal and substrate compaction) at fording and stream crossing locations within the LSA; suspension of TSS and organic material in the water column and potential spills / leaks of hydrocarbon leading to temporary adverse effects on fish habitat in the RSA at and downstream of fording and stream crossing locations – Increased predation pressure within the RSA due to improved accessibility of watercourses – Disturbance and potential mortality to fish within the LSA during stream fording and activity on / near watercourses	– Changes to physical habitat (e.g., vegetation removal and substrate compaction) at fording and stream crossing locations within the LSA; suspension of TSS and organic material in the water column and potential spills / leaks of hydrocarbon leading to temporary adverse effects on fish habitat in the RSA at and downstream of fording and stream crossing locations – Increased predation pressure within the RSA due to improved accessibility of watercourses – Disturbance and potential mortality to fish within the LSA during stream fording and activity on / near watercourses

Table 13.3.9-1 Cumulative Environmental Effects Summary: Freshwater Fish and Fish Habitat (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula[b]
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter	– not applicable	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter	– Forest harvesting activities within the RSA may result in temporary increases in sediment and particulate matter; vegetation removal may increase risk of soil erosion, which may run off into watercourses – Maintenance of existing roads, including culverts and bridges, may result in temporary increases in sediment and particulate matter
Cumulative Environmental Effects Summary[c]	**Not Significant** – Sedimentation and vegetation removal from other projects are localized, and unlikely to overlap temporally and spatially with the Project	– not applicable	**Not Significant** – Sedimentation and vegetation removal from other projects are localized, and unlikely to overlap temporally and spatially with the Project	**Not Significant** – Sedimentation and vegetation removal from other projects are localized, and unlikely to overlap temporally and spatially with the Project	**Not Significant** – Sedimentation and vegetation removal from other projects are localized, and unlikely to overlap temporally and spatially with the Project

(a) Marine environment. Applicable to the Marine VECs only.
(b) For the Marine VECs, this area comprises the Island of Newfoundland electrode site only.
(c) Total (cumulative) change from the existing environment. Significance of cumulative effects evaluated using same definitions as for the Project Environmental Effects Analysis.

Combined effects on Fish and Fish Habitat from the Project and other projects are not likely to be significant, since significant changes to baseline conditions are not likely. Due to the similar nature of the effects of forestry and road construction and maintenance activities, the extent, magnitude and duration of their effects are likely to be of low magnitude. Project activities are not likely to be static and for the most part will be moving along the corridor with minimal interaction with the VEC, thereby limiting disruption to any one area. The frequency of likely combined effects would depend on the location and activity periods of the future projects in or near waterbodies.

13.3.10 Monitoring and Follow-up

Regular testing of TSS will be conducted in the LSA during construction activities, to ensure that the CCME PAL guideline is not exceeded. The guideline for TSS is dependent on the baseline level; in clear flow conditions, a maximum increase of 25 mg/L from background levels is permitted for any 24-h period (or an increase of 5 mg/L from background levels for periods); however, under high flow conditions, a maximum increase of 25 mg/L from background levels is permitted at any time when background levels are between 25 and 250 mg/L, or a maximum increase of within 10% of background levels when background is ≥ 250 mg/L. Water testing would include collection of water samples prior to work near a waterbody (e.g., bridge crossing) or fording to establish current baseline conditions. Samples would subsequently be collected at regular intervals or at select stages of an activity to determine whether guidelines have been or are likely to be exceeded. Activities would be modified based on the test results to avoid guideline exceedance. If mitigation measures for sediment run-off control are proven to be effective by the results of TSS monitoring, regular testing for nutrients will not be conducted.

Monitoring may be required as a condition of approval for a fording permit or to ensure compliance with regulations regarding water releases and deleterious substances under the *Fisheries Act* and provincial Water and Sewer regulations. Nalcor will comply with regulatory requirements to monitor Water Quality during the Project. These data would also be entered into Nalcor's ISO documentation.

13.4 Environmental Assessment Summary

This section presents a summary of the EA for the Freshwater Environment. Subsections address the following:

- effects management measures planned for the Project to address identified issues;
- species of Special Conservation Concern and their assessment;
- potential effects of moderate to high risk accidents and malfunctions and planned mitigation and response measures;
- predicted likely residual Project effects and their significance;
- likely cumulative environmental effects associated with the Project; and
- environmental monitoring and follow-up programs planned in relation to the Project.

13.4.1 Effects Management Measures

Table 13.4.1-1 and Table 13.4.1-2 provide a summary of the effects management measures that Nalcor has incorporated into the Project for Construction, and Operations and Maintenance, respectively. Nalcor will use best management practices and accepted, proven mitigation options to avoid or reduce the effects of the Project on Freshwater Resources and Fish and Fish Habitat. Further, through their adaptive management process, Nalcor will assess issues that arise so that appropriate changes can be made to mitigation strategies or methods, and adopted in a timely manner.

Table 13.4.1-1 Construction Mitigation Strategies and Methods – Freshwater Environment

VEC	Proposed Mitigation
Freshwater Resources (Water Quality)	– Site evaluations of selected watercourse crossing locations will be conducted during final route selection, and the information provided to obtain required permits. – Bridges or culverts will be installed on larger and / or steeper-banked watercourses, where possible, and will be sized and installed appropriately. – A permit will be obtained prior to each fording activity and permit conditions will be followed. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Restrict crossings to a single location and cross at right angles to the waterbody where possible. – Minimize disturbance within the waterbody by minimizing the number of crossings. – Where possible, crossing locations (including fording, culverts and bridges) will be chosen where the banks and substrate are not sensitive to erosion. If a crossing must occur where the banks of the watercourse or waterbody are sensitive to erosion, the bank will be modified to minimize the potential for erosion. This includes directing natural drainage around areas of disturbed soil and erosion control techniques (i.e., riprap, filter fabric, and placement of gravel or wood chips) and / or revegetation, as appropriate. – At watercourse crossings, the width of the cleared ROW will be reduced to 3 m for a minimum 20 m distance away from the shoreline. Where practical, the reduced ROW width will apply for the entire buffer zone if greater than 20 m. This could include selective cutting in these areas. – To the extent practical, construction activities in waterbodies or watercourses will be scheduled to occur during low flow or frozen conditions, to avoid sensitive periods / habitat for fish, and will be shut down during heavy precipitation events. – Sediment traps / siltation control structures (i.e., silt curtains, sediment fences) and drainage collectors will be installed and maintained at appropriate locations. – A temporary timber bridge will be installed where practical to minimize siltation of watercourses or waterbodies. – Equipment will be inspected to confirm it is in proper working order prior to each ford. – Fuelling of mobile equipment will not be permitted within 50 m of a watercourse or waterbody. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment. – Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water. – Compliance with regulations regarding discharge of run-off from construction activities.

Table 13.4.1-1 Construction Mitigation Strategies and Methods – Freshwater Environment (continued)

VEC	Proposed Mitigation
Fish and Fish Habitat	– Site evaluations of selected watercourse crossing locations will be conducted during final route selection, and the information provided to obtain required permits. – Bridges or culverts will be installed on larger and / or steeper-banked watercourses, where possible, and will be sized and installed appropriately. – A permit will be obtained prior to each fording activity and permit conditions will be followed. – A permit will be obtained for all construction activity that is located within 15 m of the high water mark of a waterbody. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Restrict crossings to a single location and cross at right angles to the waterbody where possible. – Minimize disturbance within the waterbody by minimizing the number of crossings. – Where possible, crossing locations (including fording, culverts and bridges) will be chosen where the banks and substrate are not sensitive to erosion. If a crossing must occur where the banks of the watercourse or waterbody are sensitive to erosion, the bank will be modified to minimize the potential for erosion. This includes directing natural drainage around areas of disturbed soil and erosion control techniques (i.e., riprap, filter fabric, and placement of gravel or wood chips) and / or revegetation, as appropriate. – At watercourse crossings, the width of the cleared ROW will be reduced to 3 m for a minimum 20 m distance away from the shoreline. Where practical, the reduced ROW width will apply for the entire buffer zone if greater than 20 m. This could include selective cutting in these areas. – To the extent practical, construction activities in waterbodies or watercourses will be scheduled to occur during low flow or frozen conditions, to avoid sensitive periods / habitat for fish, and will be shut down during heavy precipitation events. – Sediment traps / siltation control structures (i.e., silt curtains, sediment fences) and drainage collectors will be installed and maintained at appropriate locations. – A temporary timber bridge will be installed where practical to minimize siltation of watercourses or waterbodies. – Equipment will be inspected to confirm it is in proper working order prior to each ford. – Fuelling of mobile equipment will not be permitted within 50 m of a watercourse or waterbody. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment. – Appropriate storage and handling of fuels and hazardous or controlled products including storing fuels and oils at least 100 m away from any surface water. – Compliance with regulations regarding discharge of run-off from construction activities. – Nalcor will enforce a ‘no-harvesting’ policy during working hours for all Project personnel.

Table 13.4.1-2 Operations and Maintenance Mitigation Strategies and Methods – Freshwater Environment

VEC	Proposed Mitigation
Freshwater Resources (Water Quality)	– Bridges or culverts will be installed on larger and / or steeper-banked watercourses, where possible, and will be sized and installed appropriately. – A permit will be obtained prior to each fording activity and permit conditions will be followed. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Restrict crossings to a single location and cross at right angles to the waterbody where possible. – Minimize disturbance within the waterbody by minimizing the number of crossings. – Where possible, crossing locations (including fording, culverts and bridges) will be chosen where the banks and substrate are not sensitive to erosion. If a crossing must occur where the banks of the watercourse or waterbody are sensitive to erosion, the bank will be modified to minimize the potential for erosion. This includes directing natural drainage around areas of disturbed soil and erosion control techniques (i.e., riprap, filter fabric, and placement of gravel or wood chips) and / or revegetation, as appropriate. – To the extent practical, construction activities in waterbodies or watercourses will be scheduled to occur during low flow or frozen conditions, to avoid sensitive periods / habitat for fish, and will be shut down during heavy precipitation events. – Sediment traps / siltation control structures (i.e., silt curtains, sediment fences) and drainage collectors will be installed and maintained at appropriate locations. – A temporary timber bridge will be installed where practical to minimize siltation of watercourses or waterbodies. – Equipment will be inspected to confirm it is in proper working order prior to each ford. – Fuelling of mobile equipment will not be permitted within 50 m of a watercourse or waterbody. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment of hazardous products. – Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002. – Equipment will be maintained in good working order. – Adherence to the specifications in the DFO NLOS document "Maintenance of Riparian Vegetation in Existing Rights of Way" where possible. – Natural mitigation - crossing locations required for maintenance will become increasingly established and relatively stabilized; low inspection frequency. – Compliance with regulations regarding discharge of run-off from construction activities required during Operations and Maintenance.

Table 13.4.1-2 Operations and Maintenance Mitigation Strategies and Methods – Freshwater Environment (continued)

VEC	Proposed Mitigation
Fish and Fish Habitat	– Bridges or culverts will be installed on larger and / or steeper-banked watercourses, where possible and will be sized and installed appropriately. – A permit will be obtained prior to each fording activity and permit conditions will be followed. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Restrict crossings to a single location and cross at right angles to the waterbody where possible. – Minimize disturbance within the waterbody by minimizing the number of crossings. – To the extent practical, activities in waterbodies or watercourses will be scheduled to occur during low flow or frozen conditions, to avoid sensitive periods / habitat for fish, and will be shut down during heavy precipitation events. – Sediment traps / siltation control structures (i.e., silt curtains, sediment fences) and drainage collectors will be installed and maintained at appropriate locations. – A temporary timber bridge will be installed where practical to minimize siltation of watercourses or waterbodies. – Equipment will be inspected to confirm it is in proper working order prior to each ford. – Fuelling of mobile equipment will not be permitted within 50 m of a watercourse or waterbody. – Spill kit and trained personnel will be present on-site at all times, allowing for prompt containment. – Nalcor will use non-residual herbicides (i.e., Tordon 101 with Sylgard 309 as a surfactant) and mechanical methods, where practical. The requirements of the applicable regulations will be met or exceeded. All herbicide applications will be conducted by qualified, trained personnel in a careful manner, following the manufacturers' instructions and as per the Pesticides Control Regulations 1996 (plus amendments) under the *Environmental Protection Act* SNL 2002. – Equipment will be maintained in good working order. – Adherence to the specifications in the DFO NLOS document "Maintenance of Riparian Vegetation in Existing Rights of Way" where possible. – Natural mitigation - crossing locations required for maintenance will become increasingly established and relatively stabilized. – Compliance with regulations regarding discharge of run-off from construction activities required during Operations and Maintenance. – Nalcor will enforce a 'no-harvesting' policy during working hours for all maintenance and repair personnel.

13.4.2 Species of Special Conservation Concern

An overview of freshwater fish SSCC was presented in Section 10.4.6. This section summarizes how the protected species (i.e., those on *SARA* Schedule 1 or *NLESA*) and those listed by COSEWIC or assessed by the provincial SSAC that have the potential to interact with the Project are addressed in this assessment. How such species are addressed, a brief description of the predicted effects, and an indication of the predicted significance of likely Project effects are listed in Table 13.4.2-1.

Table 13.4.2-1 Summary Effects: Species of Special Conservation Concern – Freshwater Environment

Species of Concern[a]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
American eel	Effects and mitigation addressed as part of the Fish Abundance and Species Assemblage KI under the Fish and Fish Habitat VEC	– Local disturbance (e.g., temporary scattering of fish during construction) and potential mortality (e.g., young fish may be injured or killed due to crushing as they retreat to their home territory) to fish during stream fording and activity on or near watercourses (e.g., culvert or bridge construction) – Abundance may change due to changes in habitat and water quality – Increased mortality from increased angling pressure due to improved accessibility along the ROW, and vulnerability to raptors – Improperly installed culverts may prevent upstream passage of resident migratory fish species (American eel)	Not significant

[a] Includes Species of Special Conservation Concern (i.e., *SARA* Schedule 1, *NLESA*, COSEWIC and / or SSAC) with the potential to occur along or near the transmission corridor only.

The freshwater fish SSCC were not evaluated separately, and no species-specific predictions were made. Effects and mitigation measures for these species were assessed as part of the Fish Abundance and Species Assemblage KI under the Fish and Fish Habitat VEC and predicted to be not significant. However, the mitigation measures proposed by Nalcor for the Project, i.e., adherence to permit conditions and where possible, follow the mitigation in the NLOSs, standard construction methods, the Environmental Protection Plan (EPP) and other environmental documentation, are likely to result in Project effects on Fish Abundance and Species Assemblage as summarized in Table 13.4.2-1. It is likely that a change in Fish Abundance and Species Assemblage will be evident, but within the normal range of variability. Project effects on freshwater fish are predicted to be of low to moderate magnitude, local to regional in geographic extent, and short-term to far future duration. No significant change to Fish and Fish Habitat (i.e., no changes in Fish Habitat or Fish Abundance and Species Assemblage such that the Freshwater environment is unable to recover) is predicted to occur as a result of the Project. Thus, the Project effects, including cumulative effects, on freshwater fish SSCC are likely to be not significant. No monitoring or follow-up programs are planned for fish SSCC.

13.4.3 Accidents and Malfunctions

Chapter 5 identifies and describes potential incidents (i.e., accidents and malfunctions) related to Project Construction, and Operations and Maintenance. It also describes the potential environmental consequence (i.e., magnitude, extent and duration) of these incidents and their probability of occurrence. The risk of each incident, a function of both probability of occurrence and environmental consequence, was then assessed as low, moderate or high.

Incidents that are considered to have low risk (i.e., have a low to high probability of occurrence, and a low consequence, such as hydrocarbon spills and / or leaks from equipment during all construction activities conducted in or near waterbodies) are assessed as part of the environmental effects assessment for potentially affected Freshwater Environment VECs in this chapter. Incidents that are considered to have a moderate to high risk and have potential effects on the Freshwater Environment are addressed in this section. Table 13.4.3-1 lists the moderate to high risk incidents that may affect the Freshwater Environment. Potential effects of the incident, prevention measures implemented during normal Construction, and Operations and Maintenance activities, and response measures that will be implemented in the case of an unexpected incident are summarized in Table 13.4.3-1. Because they are unlikely to occur in the freshwater environment and effects management measures will be in place to address such incidents, these moderate to high risk incidents are not likely to be significant.

Table 13.4.3-1 Summary of Potential Moderate to High Risk Incidents that Could Affect the Freshwater Environment

Description of Incident	Likely Effects on the Freshwater Environment	Prevention and Response Measures
Large spill (i.e., 1,000 L) of diesel fuel during construction that spills over the ground and into a watercourse	– Direct mortality of aquatic wildlife, including fish – Reduction in water quality and quality of fish habitat – Loss or alteration of wildlife habitat – Loss or alteration of aquatic vegetation	– The SHERP (Safety, Health and Environment Emergency Response Plan) will contain a spill prevention and response plan – The EPP will contain conditions for fuel handling and storage, including procedures for spill response – Spill kits will be available at all worksites – A spill response team will be formed and trained – Spills will be reported to the appropriate federal or provincial authority to coordinate the provincial response – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act* – Fuelling or servicing of mobile equipment on-land will not be permitted within 50 m of a waterbody – Biodegradable lubricants and hydraulic fluids will be used, where practical, when working near waterbodies – Spills or leaks of a hazardous substance into a waterbody will be reported to the appropriate provincial and federal authorities – Converter station sites will be surrounded by a constructed berm or dyke to prevent release of transformer oils or other substances into the environment
Large forest fire in Labrador originating along the access roads or ROW, during the summer	– Change in surface water quantity and quality – Increased sedimentation could affect Fish and Fish Habitat	– Adherence to terms and conditions of Operating Permits issued by the Forest Services Branch – The SHERP will contain a fire prevention plan – The EPP will contain forest fire prevention measures and a fire response plan – Firefighting equipment will be available at each worksite – In the event of a forest fire, immediate steps will be taken to extinguish the fire (if safe to do so), and the fire will be reported to the provincial Forest Services Branch
Forest fire near a populated community in Newfoundland, originating along the access roads or ROW, during the summer	– Change in surface water quantity and quality – Increased sedimentation could affect Fish and Fish Habitat	– Adherence to terms and conditions of Operating Permits issued by Forest Services Branch – The SHERP will contain a fire prevention plan – The EPP will contain forest fire prevention measures and a fire response plan – Firefighting equipment will be available at each worksite – In the event of a forest fire, immediate steps will be taken to extinguish the fire (if safe to do so), and the fire will be reported to the provincial Forest Services Branch

The following sections provide a description of the conditions or activities that could lead to each incident, the potential effects of the incident on the Freshwater Environment, and a description of prevention and mitigation measures that will be implemented by Nalcor. Additional information on each incident is provided in Chapter 5.

Large spill of diesel fuel during construction that spills over the ground and into a watercourse.

Description of Incident

During Project Construction, and Operations and Maintenance, environmentally hazardous materials such as hydrocarbons (e.g., gasoline and diesel), lubricating oils and hydraulic fluid will be used. Diesel fuel for the re-fuelling of heavy equipment will be transported in a 1,000 L portable fuel storage tank. There is a potential that this fuel tank is breached due to a mishap (e.g., roll over), and that up to 1,000 L of diesel fuel spills over the ground and into a watercourse.

Likely Effects of Incident on the Freshwater Environment

Diesel fuel that spills over the ground and into a watercourse will affect the quality of the water in the receiving body. The fuel spill could result in the direct mortality of aquatic species (including fish, aquatic birds, amphibians and invertebrates) and / or the loss or alteration of freshwater vegetation and habitat. The effects of a diesel fuel spill may be felt downstream of the spill location. The extent of the effects would depend on the proximity of the spill to the watercourse, amount of fuel released and the rate of mixing in the receiving watercourse. The ability of response crews to isolate and clean up the spill may also be affected by watercourse properties such as its size, depth and flow rate.

Summary of Prevention and Response Measures

The SHERP (Safety, Health and Environment Emergency Response Plan) will include specific instructions for the prevention of and response to spills or leaks of hazardous materials. The EPP will also contain material handling and storage measures and the spill response plan. Spill response kits will be maintained at all worksites, and spill kit contents will be based on the volume of fluids in use, the type of fluid, proximity to water and other relevant factors. All personnel involved in hydrocarbon transport and transfer will be trained in spill response. A Response Team will be formed, trained prior to commencement of construction and will receive regular practice in “mock” responses for incidents that require co-ordinated action. Any spills in excess of the amount, concentration, level or rate of release authorized by the *NLEPA* or any Project approvals granted under the *NLEPA* will be reported to the NLDEC.

All mobile storage tanks will be registered under, and comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* Records of the contents of all storage tanks will be maintained to reconcile inventories as a check against undetected leakage. All transport vehicles will be licensed and maintained according to safety requirements. Fuelling or servicing of mobile equipment on-land will not be permitted within 50 m of a waterbody. Further, appropriate storage and handling of fuels and hazardous or controlled products will include storing fuels and oils at least 100 m away from any surface water.

Large forest fire in Labrador, originating along the access roads or ROW, during the summer, or forest fire near a populated community in Newfoundland, originating along the access roads or ROW, during the summer.

Description of Incident

The operation of combustion engines (e.g., vehicles, heavy equipment, chainsaws), blasting activity and workers smoking have the potential to ignite forest fires. Both combustion engines and workers are expected to be present during most Project Construction, and Operations and Maintenance activities, and blasting may occur during foundation construction. Several Project activities will occur in forested areas where the ignition source could lead to a forest fire.

Given the Forest Services Branch's policy not to fight fires that do not threaten communities or harvestable resources, a forest fire in Labrador could affect large tracts of land. A large forest fire in Labrador is considered to cover an area of approximately 470 hectares (the average extent of forest fires in Labrador) or more. A similar fire in Newfoundland would be more actively fought but has a greater likelihood of approaching a populated community.

Likely Effects of Incident on the Freshwater Environment

A forest fire can affect both the quantity and quality of surface water available. The increased sunlight reaching the forest floor results in a more rapid snow melt and higher water levels in surface waterbodies and watercourses over a short period of time during the spring. The increased sunlight can also cause a burned area to dry out more quickly.

Water Quality may be affected by increased erosion (i.e., due to the reduction in vegetative cover) and sedimentation, but sedimentation is expected to decrease once the vegetation regenerates (NRCan 2011, internet site). Sedimentation can affect fish by damaging their gills and also by reducing visibility and making it more difficult for fish to find food. Sedimentation can also prevent the necessary sunlight from reaching aquatic vegetation.

Summary of Prevention and Response Measures

The SHERP will include a plan for fire prevention. The EPP will also contain fire prevention measures and the fire response plan. All Project personnel will be made aware of the SHERP and designated staff will receive SHERP training. The forest fire prevention plan will be followed by Nalcor and its contractors. Forest fire prevention measures addressed in the SHERP and EPP will include the storage and disposal of flammable material, the use of designated smoking areas and the prohibition of burning brush or debris.

Detailed information on firefighting equipment and procedures will be provided in the SHERP, the EPP and other environmental documents, such as terms and conditions of permits and authorizations. Firefighting equipment, as described in Chapter 5, that is suitable to the labour force and working conditions will be available at each worksite and will be in proper working condition, as required by the Operating Permit obtained from the Forest Services Branch. In the event of a forest fire, immediate steps will be taken to contain or extinguish the fire to the extent practical and safe, and fires will be reported immediately to the nearest regional office of the Forest Services Branch, the branch of government responsible to coordinate the province's fire suppression program.

Summary of Assessment of Moderate to High Risk Accidents and Malfunctions

The likely effects of the release of a large amount of diesel fuel or other hazardous material or a large forest fire in Labrador or a forest fire near a community in Newfoundland on the Freshwater Environment during Project Construction, or Operations and Maintenance are primarily reduced Water Quality and Fish Habitat and, potentially, fish mortality at and downstream of the spill or fire site through the introduction of sediment and / or hazardous materials into the watercourse. Nalcor will implement leak and spill prevention measures and fire prevention measures in accordance with relevant regulations, and adhere to conditions of relevant permits, and other mitigation measures presented in this chapter. Spill kits, firefighting equipment, and trained personnel will be on-site and, if necessary, the spill or fire response plan outlined in the SHERP (Section 5.10.1) and the EPP will be implemented. Consequently, hazardous materials release events and forest fires will be prevented to the extent possible. A spill or forest fire that does occur will be dealt with quickly to reduce the spread of hazardous materials or fire, and the consequent reduction in water and fish habitat quality, and effect on fish populations. Prevention and response measures are in place and moderate to high risk spill or forest fire incidents are unlikely to occur; therefore, the effects are not likely to be significant.

13.4.4 Residual Project Effects and Significance

The environmental effects assessment framework used considers the overall ecological context, and integrally reflects ecological and socioeconomic interrelationships between VECs, others aspects of the natural and human environments, and associated Project related issues as identified in the interaction tables. Nalcor's attention to sustainability as fundamental to the assessment also reflects the intent to respect ecosystem integrity, including the capability of natural systems to maintain their structures and functions, and to support biological diversity. By assessing the Freshwater Resources (Water Quality) and Fish Habitat which form the basis of the environment for freshwater fisheries, the EIS considers the extent to which freshwater biological diversity is affected by the Project. This section summarizes the residual Project effects on the Freshwater Environment and their significance.

Nalcor continues to consider possible Project interactions with the Freshwater Environment during Project planning, and will have effects management measures in place to minimize residual Project effects on the Freshwater Environment during both Construction and Operations and Maintenance phases as presented in Table 13.4.1-1 and Table 13.4.1-2. Work conducted on or near water is regulated and permit-based, and the mitigation measures are standard industry best practices, proven to be effective in maintaining the integrity of freshwater ecosystems. Nalcor's planned ongoing communication with regulatory agencies and application for permits as required to work on or near watercourses during Project Construction and Operations and Maintenance, careful adherence to permit conditions, consideration of Nalcor's past experience, and contingency and response measures included in the EPP to address issues that do arise will minimize residual effects on the Freshwater Environment.

The likely residual effects on Freshwater Resources (Water Quality) will result from fording activities, stream crossing installation, and soil disturbance from vegetation removal and rutting. They are primarily temporary and localized in nature, occurring mainly during Project Construction but also during the conduct of maintenance activities on or near watercourses during Project Operations and Maintenance. These include temporary increases in TSS and nutrients, toluene or ethylbenzene in exceedance of guidelines or relative to baseline conditions due to accidental leaks or spills, and the potential presence of herbicide in the water as a result of vegetation maintenance. Foreign matter entering a watercourse is unlikely to be in quantities that would significantly affect water quality relative to baseline or would cause an exceedance of CCME guidelines. Therefore, the Project is not likely to result in significant adverse environmental effects on the Freshwater Resources VEC.

The likely residual effects of Project Construction, and Operations and Maintenance activities on fish and fish habitat include localized (i.e., at the watercourse crossing) physical changes to fish habitat from sedimentation, increased erosion and accidential hydrocarbon release and water quality changes. Residual effects on fish species and assemblages will be limited both spatially and in duration, and include temporary scattering from the work area due to noise / vibration, impairment to upstream movement due to poor culvert installation, change in fish assembalge due to a change in habitat and water quality, increased vulnerability to injury from crushing and capture by raptors. Increased fishing pressure by anglers and poachers is also a threat to sport fish populations. However, considering the planned mitigation measures and adherence to permit conditions for Project activites on or near the freshwater environment, effects will not be of sufficient magnitude, duration and geographic extent to cause a change in the Fish and Fish Habitat that will alter its status or integrity beyond an acceptable level. Therefore, the Project is not likely to result in significant adverse environmental effects on the Fish and Fish Habitat VEC.

Table 13.4.4-1 provides a summary of the significance of effects on the Freshwater Environment.

Table 13.4.4-1 Summary: Significance of Effects on the Freshwater Environment

VEC	Likely Significant Effect	Comment
Freshwater Resources	No	The likely effects on Freshwater Resources (Water Quality) during Project Construction, and Operations and Maintenance consider standard, proven, effective mitigation. The effects are well understood, are unlikely to result in a decrease in the water quality of a given watercourse, such that applicable guidelines are exceeded, or the watercourse cannot sustain its baseline functions over the lifetime of the Project.
Fish and Fish Habitat	No	The likely effects on Fish Habitat, and Fish Abundance and Species Assemblage during Project Construction, and Operations and Maintenance consider standard, proven, effective mitigation. The effects are well understood, will be localized, are unlikely to affect the baseline functions or alter, disrupt or destroy Fish Habitat and / or affect Fish Abundance and Species Assemblage over the lifetime of the Project such that the Freshwater Environment is unable to recover.

While the Project is likely to have residual effects on the Freshwater Environment as represented by the VECs assessed, effects will be within the capacity of the environment. The changes to the Freshwater Environment resulting from the Project are unlikely to affect its baseline functions and, consequently, fish or fish habitat over the lifetime of the Project, based on the prediction that there will be no significant effects on the Water Quality KI, Fish Habitat KI or Fish Abundance and Species Assemblage KI. Therefore, residual effects on the Freshwater Environment are likely to be not significant.

13.4.5 Cumulative Environmental Effects

The cumulative effects assessment considered the overall effect on the Freshwater Environment VECs as a result of the Project's residual environmental effects in combination with those of other projects and activities that have been or will be carried out. The existing environment considers all projects and activities that have been undertaken in the past, or are ongoing. The future projects and activities considered for the cumulative effects assessment included those with potential overlapping environmental effects within the RSA. This included effects (e.g., temporary increases in sediment and particulate matter due to vegetation removal causing increased risk of soil erosion, which may lead to run off into watercourses) resulting from forest harvesting activities and maintenance of existing roads, including bridges and culverts.

Overall, the contributions of sedimentation and increased particulate matter to the Freshwater Environment from the potential future projects are unlikely to add, or may add infrequently, to the short-term change in Water Quality and Fish and Fish Habitat from the Project as they are unlikely to overlap temporally or spatially. This is because Project activities will generally move along the transmission corridor resulting in short-term localized effects, and the frequency of potential combined effects would depend on the activity periods and locations of the future projects in or near water work locations associated with the Project.

The cumulative effects of the Project on Freshwater Resources and Fish and Fish Habitat in combination with other projects and activities that have been or will be carried out are predicted to be not significant as they are unlikely to spatially or temporally overlap within the RSA and where they occur simultaneously, effects will be limited to low magnitude and localized effects.

13.4.6 Environmental Monitoring and Follow-up

A follow-up program to measure Water Quality or fish population attributes for the purpose of verifying the environmental effects predictions or the effectiveness of mitigation is not warranted as standard best practices are in place to address the well understood effects.

However, during Construction activities, regular testing of TSS will be conducted to confirm that the CCME PAL guideline is not exceeded or to direct modification of activities to reduce identified exceedances, as described in Section 13.3.10. Nalcor will also conduct monitoring, as described in Section 13.3.10, to comply with provincial and federal permits and regulatory requirements during the life of the Project.

13.5 References

AMEC (AMEC Earth and Environmental). 2010. Labrador – Island Transmission Link: Freshwater Environment – Fish and Fish Habitat and Water Resources. Prepared for Nalcor Energy, St. John's, NL.

AMEC. 2011. Labrador – Island Transmission Link: Freshwater Environment – Fish and Fish Habitat and Water Resources Component Study: Supplementary Report. Prepared for Nalcor Energy, St. John's, NL.

Carroll, M.B. 2008. The Effects of Stream Crossings and Associated Road Approaches on Water Quality in the Virginia Piedmont. M. Sc. Thesis, Virginia Polytechnic Institute and State University. Virginia, USA.

CCME (Canadian Council of Ministers of the Environment). 2002. Canadian Environmental Quality Guidelines: Summary Table. Winnipeg, MB.

CEA Agency (Canadian Environmental Assessment Agency). 1994. Canadian Environmental Assessment Agency Responsible Authority's Guide.

Chilibeck, B., G. Chislett and G. Norris. 1993. Land Development Guidelines for the Protection of Aquatic Habitat. Department of Fisheries and Oceans and the Integrated Management Branch of the Ministry of Environment, Lands and Parks.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011. Wildlife Species Search. Available at: http://www.cosewic.gc.ca/eng/sct1/index_e.cfm. Accessed: April 2011.

DFO (Fisheries and Oceans Canada). 2010. Newfoundland and Labrador Operational Statements. Available at: http://www.dfo-mpo.gc.ca/habitat/what-quoi/os-eo/nl/riparianveg-eng.asp. Accessed: September 2010.

DFO. 2011. Newfoundland and Labrador Habitat Management Program. Mitigation Techniques. Temporary Fording Sites. Available at: http://www.nfl.dfo-mpo.gc.ca/e0005517. Accessed: August 2011.

Environment Canada. 2007. Canada-Newfoundland / Labrador Aqua Link (CANAL). Available at: http://map.ns.ec.gc.ca/canal/root/main/main.asp. Accessed: June 2010.

Gibson, R. J., D. E. Stansbury, R. R. Whalen and K. G. Hillier. 1993. Relative Habitat Use, and Inter-specific and Intra-specific Competition of Brook Trout (*Salvelinus fontinalis*) and Juvenile Atlantic Salmon (*Salmo salar*) in some Newfoundland Rivers. In R. J. Gibson and R. E. Cutting (ed.). Production of Juvenile Atlantic Salmon, Salmo Salar, in Natural Waters. Can. Spec. Publ. Fish. Aquat. Sci. 118: 53-69.

GNL (Government of Newfoundland and Labrador). 2011. Department of Environment and Conservation. Species at Risk. Available at: http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/index.html. Accessed: March 2011.

Gosse, M.M., A.S. Power, D.E. Hyslop and S.L. Pierce. 1998. Guidelines for the Protection of Freshwater Fish Habitat in Newfoundland and Labrador. Fisheries and Oceans, St. John's, NL.

Health Canada. 2010. Guidelines for Canadian Drinking Water Quality Summary Table. December 2010. 14.p.

Jackson, J., E. Pentecost and J. Muzzarelli. 1994. Transmission Line Environmental Assessment Guidance Document. ANL/EAD-TM-3, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois. 62 p.

Knight, R. L. 1988. Relationship of birds of prey and riparian habitat in the Pacific Northwest: An overview. Pages 79-91 in K. J. Raedeke, editor. Streamside Management: Riparian Wildlife and Forestry Interactions. Institute of Forest Resources Contribution No. 59. University of Washington, Seattle, WA.

Knight, A.W., and R.L. Bottorff. 1984. The Importance of Riparian Vegetation to Stream Ecosystems. In R.E. Warner and K.M. Hendrix (ed.), California Riparian Systems, Ecology, Conservation, and Productive Management. Univ. of California Press, Berkeley, CA. p. 160-167.

McCarthy, J.H. 1996. Brook charr (*Salvelinus fontinalis* Mitchell) Movement and Habitat Use in the Copper Lake Watershed, Corner Brook, Newfoundland, and a Preliminary Assessment of the Impact of Forest Harvesting Activity. M.Sc. thesis, Memorial University of Newfoundland, 171 p.

McCarthy, J.H., C.G.J. Grant and D.A. Scruton. 2007. Draft Standard Methods Guide for the Classification and Quantification of Fish Habitat Rivers in Newfoundland and Labrador.

Minaskuat Inc. 2008. Water and Sediment Modeling in the Lower Churchill River - Environmental Baseline Report LCP#535725. Prepared for Newfoundland and Labrador Hydro, St. John's, NL. 67pp + 1 appendix.

NLDEC (Newfoundland and Labrador Department of Environment and Conservation). 1999. Policy for Land and Water Related Developments in Protected Public Water Supply Areas. Available at: http://www.env.gov.nl.ca/env/waterres/regulations/policies/water_related.html. Accessed: April 2011.

NLDEC. 2001. Policy for Development in Wetlands. Available at: http://www.env.gov.nl.ca/env/waterres/regul ations/policies/wetlands.html. Accessed: September 2010.

NLDEC. 2002. Water Resources Act: An Act Respecting the Control and Management of Water Resources in the Province. Available at: http://www.assembly.nl.ca/legislation/sr/statutes/w04-01.htm. Accessed: July 2010.

NLDEC. 2011a. Species status Advisory Committee. General Status of Species. Available at: http://www.env.gov.nl.ca/env/wildlife/all_species/general_status.html. Accessed: September 2011.

NLDEC. 2011b. Hydrology and Climate of Newfoundland. Available at: http://www.env.gov.nl.ca/env/waterres/cycle/hydrologic/nl.html. Accessed: August 2011.

NRCan (Natural Resources Canada). 2011. Forest Ecosystems of Canada – Fire. Available at: http://ecosys.cfl.scf.rncan.gc.ca/perturbation-disturbance/feu-fire-eng.asp. Accessed: July 2011.

Power, G. 1993. Estimating Production, Food Supplies and Consumption by Juvenile Atlantic Salmon (*Salmo salar*). In R. J. Gibson and R. E. Cutting (ed.). Production of Juvenile Atlantic Salmon, Salmo salar, in Natural Waters. Can. Spec. Publ. Fish. Aquat. Sci. 118: 163-174.

SARA (*Species at Risk Act*). 2011. Species at Risk Public Registry. Available at: http://www.sararegistry.gc.ca/default_e.cfm. Accessed: March 2011.

Scruton, D.A., D.R. Sooley, L. Moores, M.A. Barnes, R.A. Buchanan and R.N. McCubbin. 1997. Forestry Guidelines for the Protection of Fish Habitat in Newfoundland and Labrador. Department of Fisheries and Oceans, St. John's, Newfoundland, pg 63.

Vølstad, J. H., N. E. Roth, G. Mercurio, M. T. Southerland and D. E. Strebel. 2003. Using Environmental Stressor Information to Predict the Ecological Status of Maryland Non-Tidal Streams as Measured by Biological Indicators. Environmental Monitoring and Assessment 84: 219–242, 2003.

Water Resources Management Division. 1997. Environmental Guidelines for General Construction Practices, March 24, 1997. Government of Newfoundland and Labrador, Department of Environment and Labour, Water Investigations Section.

NALCOR ENERGY

LABRADOR-ISLAND TRANSMISSION LINK

ENVIRONMENTAL IMPACT STATEMENT

Chapter 14

Marine Environment: Environmental Effects Assessment

April 2012

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

Acronym	**Description**
%	Percent
<	less than
≤	less than or equal to
>	greater than
µPa	microPascal
µT	microTesla
A	Amperes
ac	alternating current
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act*
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
dB	Decibels
dc	direct current
DFO	Fisheries and Oceans Canada
EA	Environmental Assessment
EEA	Existing Environment Area
EIS	Environmental Impact Statement
EM	Electromagnetic
EMF	Electromagnetic Field
FJGI	Fugro Jacques GeoSurveys Inc.
g	Gram
g/L	grams per litre
GPR	Ground Potential Rise
HADD	Harmful Alteration, Disruption or Destruction
hr	Hour
HVdc	High Voltage direct current
Hz	Hertz
Jasco	Jasco Applied Research
kHz	kilohertz
KI	Key Indicator
km	Kilometre
km^2	square kilometre
L	Litre

Acronym	Description
LSA	Local Study Area
m	metre
m^2	square metre
mg/L	milligrams per litre
MP	Measurable Parameter
NLESA	*Newfoundland and Labrador Endangered Species Act*
NRC	National Research Council
nT	nanoTesla
^{o}	degrees
Pa	Pascal
pers. comm.	personal communication
Project	Nalcor Energy Labrador-Island Transmission Link Project
PTS	Permanent Threshold Shift
RL	received level
rms	root mean square
ROV	Remotely Operated Vehicle
RSA	Regional Study Area
s	second
SARA	*Species at Risk Act*
SEL	Sound Exposure Level
sp.	species
SPL	Sound Pressure Level
T	Tesla
TSS	total suspended solids
TTS	Temporary Threshold Shift
US	United States
V	Volt
V/m	Volts per metre
VEC	Valued Environmental Component
W	Watt
ZOI	zone of influence

14 MARINE ENVIRONMENT

This Chapter of the Environmental Impact Statement (EIS) presents the environmental assessment for the Marine Environment, which includes Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Seabirds.

14.1 Valued Environmental Component Selection

The environmental assessment (EA) is focused on Valued Environmental Components (VECs). VECs are aspects of the biophysical and socioeconomic environments which are of particular ecological or social or economic importance, and which have the potential to be affected (adversely or positively) by the proposed Nalcor Energy (Nalcor) Labrador-Island Transmission Link (the Project). VECs reflect scientific and community concerns regarding the Project and its potential effects, and are typically identified early in an EA as a result of questions and issues raised through consultations with governments, Aboriginal and stakeholder groups and the general public.

Initial direction and input into VEC selection for this EIS were obtained through the EIS Guidelines and Scoping Document (May 2011) that were issued to Nalcor by the federal and provincial governments following Aboriginal and public review. Following additional analysis by the EIS study team and as a result of Nalcor's own consultation activities, that initial list of VECs has been expanded and refined to include the key environmental components and issues that require detailed consideration in the EIS. The VECs that have been selected as the focus for the EA for the Marine Environment, as well as the rationale for their selection, are described below.

Marine Fish and Fish Habitat was selected as a VEC because it plays a fundamental role in the maintenance of a healthy, functioning marine ecosystem (e.g., it contributes to biodiversity, forms the basis of the marine food web and supports other marine species), and social and economic systems (e.g., recreational and commercial harvesting). As well, there are fish species of conservation concern that are subject to regulatory requirements and jurisdictional, management or planning regimes, especially including those considered at risk and listed by the *Species at Risk Act* (*SARA*) and the *Newfoundland and Labrador Endangered Species Act* (*NLESA*). Both the Strait of Belle Isle and Conception Bay support recreational and commercial fisheries.

Marine Mammals and Sea Turtles was selected as a VEC because the Strait of Belle Isle and Conception Bay represent important foraging and / or migration areas for many species of marine mammals and at least one species of sea turtle; several species are considered at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are listed under *SAR*A. As well, the noise associated with certain Project activities in the Strait of Belle Isle and Conception Bay has the potential to disturb some species of Marine Mammals and Sea Turtles.

Seabirds have been identified as a VEC because they are highly visible and have wide social as well as ecological and scientific importance. The Strait of Belle Isle and Conception Bay support populations of seabirds that are globally significant in size (e.g., seaducks, alcids, and others). Several species of seabirds are listed as species of conservation concern, federally and / or provincially.

The effects of the Project on these VECs are assessed in the following sections of this chapter.

Species of Special Conservation Concern are an integral component of the effects analysis. Table 14.1-1 lists the marine fish, marine mammal, sea turtle and seabird Species of Special Conservation Concern addressed in this chapter and outlines the manner in which each species is considered in the EA. This list includes species protected under *SARA* and the *NLESA*, as well as those considered for assessment by COSEWIC and the provincial Species Status Advisory Committee (SSAC). Only species likely to occur in the Project study area are included in Table 14.1-1 and in this assessment of effects on the Marine Environment.

Table 14.1-1 Integral Consideration of Species of Special Conservation Concern in the Environmental Assessment – Marine Environment

Species of Special Conservation Concern[(a)]	How Species is Addressed in the EIS
Fish[(b)]	
White shark (Atlantic population)	Assessed in the Fish KI of the Marine Fish and Fish Habitat VEC
Atlantic wolffish	Assessed in the Fish KI of the Marine Fish and Fish Habitat VEC
Northern wolffish	Assessed in the Fish KI of the Marine Fish and Fish Habitat VEC
Spotted wolffish	Assessed in the Fish KI of the Marine Fish and Fish Habitat VEC
Marine Mammals and Sea Turtles	
Blue whale (Northwest Atlantic Ocean population)	Assessed in the Baleen Whales KI of the Marine Mammals and Sea Turtles VEC
Fin whale (Atlantic Ocean population)	Assessed in the Baleen Whales KI of the Marine Mammals and Sea Turtles VEC
Leatherback sea turtle	Assessed in the Sea Turtles KI of the Marine Mammals and Sea Turtles VEC
Seabirds	
Harlequin Duck (eastern population)	Assessed in the At-sea Seabirds KI of the Seabirds VEC
Barrow's Goldeneye (eastern population)	Assessed in the At-sea Seabirds KI of the Seabirds VEC
Ivory Gull	Assessed in the At-sea Seabirds KI of the Seabirds VEC
Red Knot, *rufa* subspecies	Assessed in the Migrating Shorebirds KI of the Seabirds VEC

(a) Only Species of Special Conservation Concern that are present within the Study Area are included in this analysis. See Section 10.5.8 (Existing Environment) for information about species presence.

(b) American eel, a catadromous species designated as Vulnerable provincially, is addressed in Section 13.4.2 as part of the Fish Abundance and Species Assemblage KI of the Fish and Fish Habitat VEC in the assessment of the Freshwater Environment.

14.2 Fish and Fish Habitat

14.2.1 Introduction

The Marine Fish and Fish Habitat VEC is defined broadly and includes various ecosystem components such as the physical and chemical characteristics of seawater and bottom substrate, flora (phytoplankton and macroalgae), invertebrate fauna (infauna, epifauna, zooplankton, macro-invertebrates in the water column) and fish fauna. This VEC is critical in that its components constitute the foundation of the marine ecological food web. Many of the direct potential effects of the Project on some members of this VEC can be considered indirect effects on fauna higher in the food web that graze or prey on the lower organisms. In addition, some of the macro-invertebrates and fishes of this VEC are important target species in various commercial and recreational fisheries.

Marine Fish and Fish Habitat occurs throughout the area associated with marine aspects of the Project. Existing environment details of the Marine Fish and Fish Habitat VEC, as it pertains to the proposed Project, are provided in Section 10.5.8. In general, of the marine biological VECs considered in this EIS, the Marine Fish and Fish Habitat VEC is likely to be most affected by the Project. However, this VEC is in a reasonably healthy state with relatively high biodiversity and is likely to be resilient to any anthropogenic stresses that might be associated with the various phases of the Project.

14.2.2 Environmental Assessment Study Areas

14.2.2.1 Spatial Boundaries

The Local Study Area (LSA) is comprised of three components: the 500 metre (m) wide submarine cable crossing corridor in the Strait of Belle Isle (Corridor LSA Component) (Figure 14.2.2-1) and the two marine areas defined by buffers of 500 m radius from the proposed shoreline electrode sites at L'Anse au Diable (L'Anse au Diable LSA Component) (Figure 14.2.2-1) in the Strait of Belle Isle, and Dowden's Point (Dowden's Point LSA Component) (Figure 14.2.2-2) in Conception Bay.

The Regional Study Area (RSA) is equivalent to the study area for the the existing environment for Marine Fish and Fish Habitat (Section 10.5.8.1). It is comprised of three components: the Strait of Belle Isle RSA Component (Figure 14.2.2-1), the Dowden's Point RSA Component (Figure 14.2.2-2) and the L'Anse au Diable RSA Component. The L'Anse au Diable RSA Component, shown in Figure 14.2.2-1, is captured within the Strait of Belle Isle RSA Component.

14.2.2.2 Temporal Boundaries

The temporal boundaries for the EA encompass a four-year period for the Project Construction phase, and an indefinite period for the Project Operations and Maintenance phase.

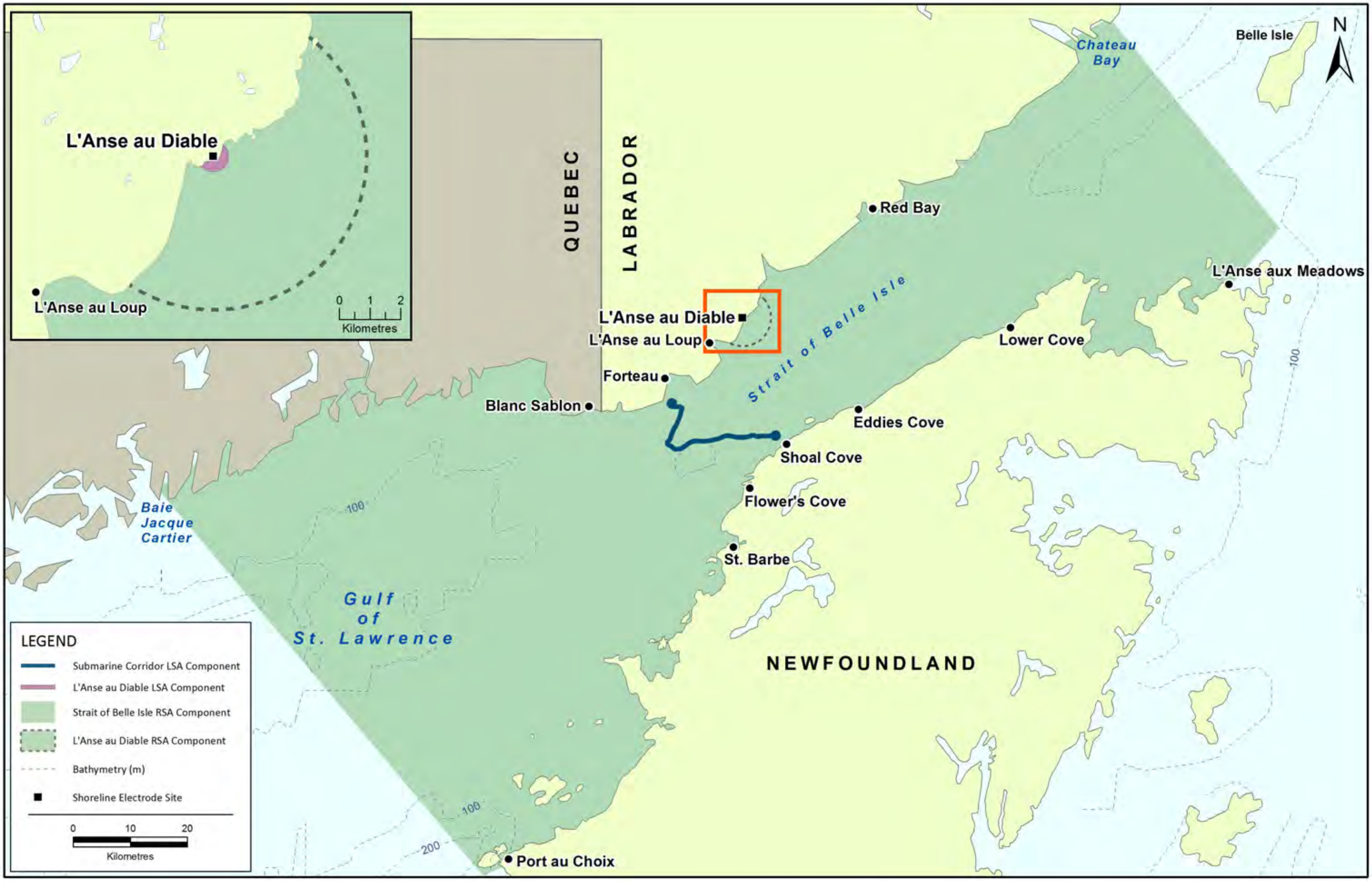
14.2.3 Potential Environmental Issues, Indicators and Interactions

14.2.3.1 Potential Environmental Issues

Issues and questions related to the Marine Fish and Fish Habitat VEC that were identified in the EIS Guidelines and Scoping Document (May 2011), through regulatory, Aboriginal and stakeholder consultation, and by the EIS study team, are presented in Table 14.2.3-1. The nature and rationale as well as specific considerations for each issue / question are also included in Table 14.2.3-1.

Table 14.2.3-1 Identified Issues and Questions: Marine Fish and Fish Habitat

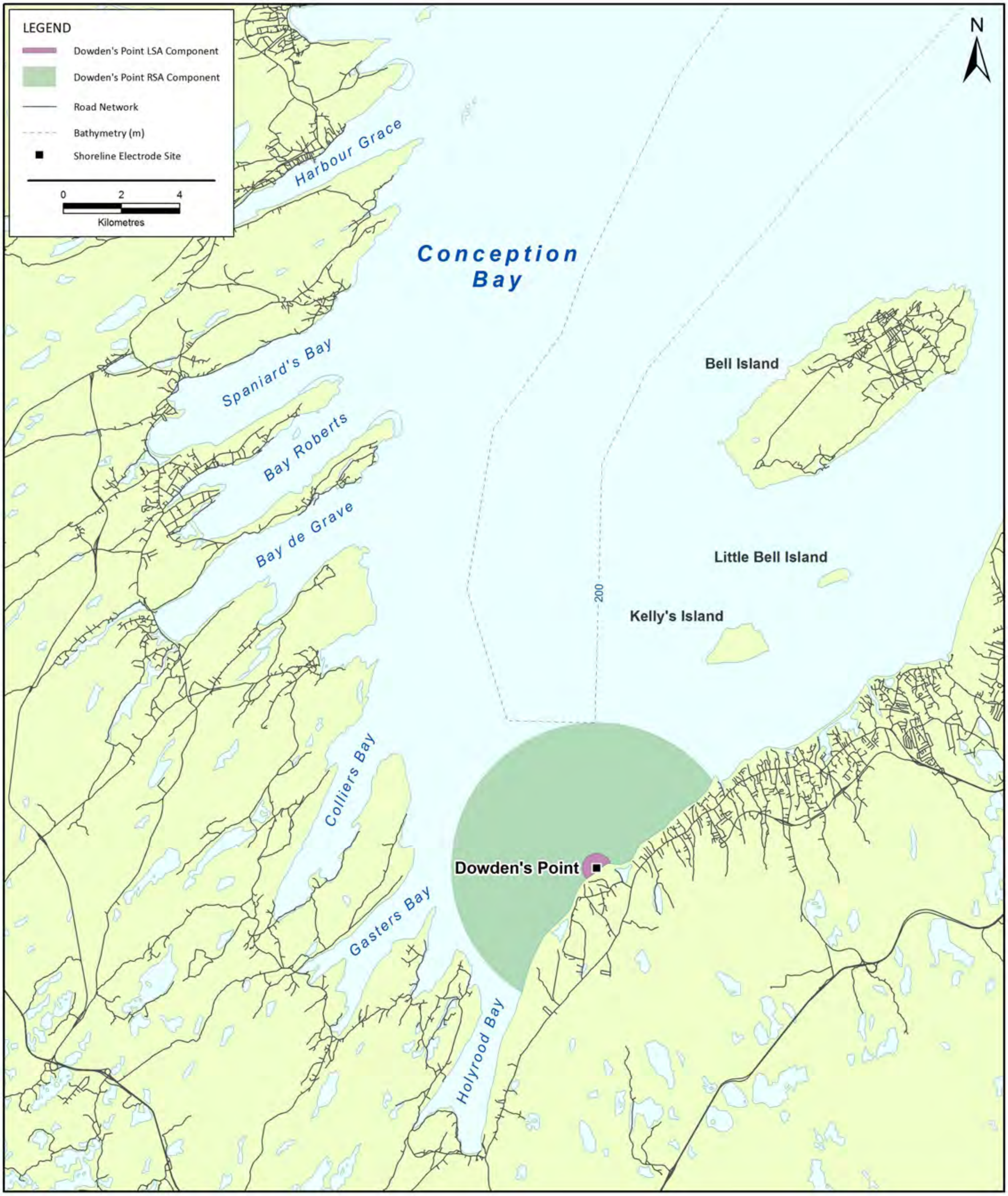
Issue / Question	Nature and Rationale	Specific Considerations
Loss of Benthic Habitat	Harmful Alteration, Disruption or Destruction (HADD) of marine fish habitat as per Section 35(2) of the *Fisheries Act*	Iceland scallop, wolffish
Changes in Marine Water Quality	Potential effects on biota behaviour and health	Most sensitive species / life stages
Underwater noise	Potential effects on macro-invertebrate and fish behaviour	Most sensitive species / life stages (e.g., capelin, herring, Atlantic salmon)
Electrode emissions	Potential effects of the introduction of electric fields, electromagnetic fields (EMFs), electrolysis products and heat on macro-invertebrate and fish behaviour and health	Most sensitive species / life stages
Cable emissions	Potential effects of the introduction of electric fields, EMFs and heat on macro-invertebrate and fish behaviour	Most sensitive species / life stages



nalcor energy

FIGURE 14.2.2-1

Marine Fish and Fish Habitat Local Study Area (LSA) and Regional Study Area (RSA) Components in the Strait of Belle Isle Area



nalcor energy

FIGURE 14.2.2-2

Marine Fish and Fish Habitat Local Study Area (LSA) and Regional Study Area (RSA) Components in the Dowden's Point Area, Conception Bay, Newfoundland

14.2.3.2 Key Indicators and Measurable Parameters

Three Key Indicators (KIs) have been selected to represent the Marine Fish and Fish Habitat VEC in the effects assessment: (i) Benthic Habitat, (ii) Marine Water Quality, and (iii) Fish (Table 14.2.3-2). The Benthic Habitat KI pertains to chemical and physical characteristics of surficial sediment, as well as the biota living in and on the seabed. The Marine Water Quality KI pertains to chemical and physical characteristics of seawater as well as the phytoplankton and zooplankton occurring in the seawater. The Fish KI pertains to the behaviour and health of various life stages of macro-invertebrates and fishes. All three KIs are present within the LSA and RSA, are good indicators of the status of the Marine Fish and Fish Habitat VEC, and have databases associated with them. In addition, there are government guidelines pertaining to some seawater chemistry parameters, and particular macro-invertebrates and fishes have commercial economic importance, subsistence or cultural importance, and / or recreational importance. Additional rationale for the selection of each KI is provided in Table 14.2.3-2. All identified issues / questions noted in Table 14.2.3-1 are addressed during the assessment process using the KIs. If any KI is affected as a result of the Project, an effect on the VEC would also occur.

An appropriate KI must have associated Measurable Parameters (MPs) which are relevant and reflect the likely effects of the Project on the Marine Fish and Fish Habitat VEC. The MPs selected for the three KIs described above, and the rationale for their selection, are included in Table 14.2.3-2.

Table 14.2.3-2 Key Indicators and Associated Measurable Parameters: Marine Fish and Fish Habitat VEC

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Benthic Habitat	– Benthic Habitat is ubiquitous in both the LSA and RSA, and is the component of the Marine Fish and Fish Habitat VEC that will be directly affected by the Project.	– Change in proportions of bottom substrate classes – Change in algal community structure – Change in benthic community structure – Change in surficial sediment chemistry	– Bottom substrate class will change in portions of the LSA. Some baseline information on bottom substrate class in the LSA is available. – Algal community structure will change in portions of the LSA. Algae constitute a valuable component of Benthic Habitat, particularly in shallow subtidal areas. They can be readily documented with underwater camera surveys. Some baseline information on algae in the LSA is available. – Benthic community structure will change in portions of the LSA. It can be readily documented with underwater camera surveys. Some baseline information on benthos in the LSA is available. – Sediment chemistry is relatively easy to monitor. Samples can be collected with either grab sampler or diver. Some baseline information on surficial sediment chemistry in the LSA is available. In addition, certain chemicals are addressed in the Canadian Council of Ministers of the Environment (CCME) guidelines for marine sediment (CCME 2011a, internet site). – Marine Benthic Habitat is an important cornerstone aspect of the ecosystem.
Marine Water Quality	– Seawater is ubiquitous in both the LSA and RSA, and it complements the 'Benthic Habitat', in terms of the habitat aspects of the Marine Fish and Fish Habitat VEC. In addition, seawater will serve as the medium for transmission of noise, electric field, EMF, and heat emissions.	– Change in turbidity – Change in seawater chemistry – Change in plankton community structure	– Turbidity of seawater is likely to change during construction of rock berms and electrode sites, as well as during water exchange between the inner part of the electrode site and the open ocean. In addition, turbidity is addressed in the CCME guidelines for marine water. – Potentially deleterious substances could be released into the seawater (e.g., hydrocarbons, chlorine species). In addition, certain chemicals are addressed in the CCME guidelines for marine water (CCME 2011b, internet site).Various types of plankton (e.g., phytoplankton, zooplankton) occur in the seawater portion of the fish habitat and could be affected by Project activities (e.g., distribution, chemical contamination). – Marine Water Quality is an important cornerstone aspect of the ecosystem.
Fish	– Macro-invertebrates and fishes constitute the upper level biotic component of the Marine Fish and Fish Habitat VEC.	– Change in migration or movement behaviour – Change in feeding behaviour – Change in spawning behaviour – Change in health	– Project activities by-products (e.g., underwater noise, electromagnetic (EM) emissions) could affect the migration or movement of various fishes (e.g., Atlantic cod and herring by sound; salmon and eels by EMF). – Project activities by-products (e.g., underwater noise, EM emissions) could affect the feeding of various macro-invertebrates and fishes (e.g., sharks and rays). – Project activities by-products (e.g., underwater noise, EM emissions) could affect the spawning behaviour of various macro-invertebrates and fishes (e.g., Iceland scallop, lumpfish). – Health of various life stages of macro-invertebrates and fishes could be affected by Project activities by-products (e.g., accidental releases of small amounts of potentially deleterious substances, such as hydrocarbons).

14.2.3.3 Potential Project-Fish and Fish Habitat Interactions

The potential interactions of Project activities and the Marine Fish and Fish Habitat VEC KIs are described in Table 14.2.3-3.

During the Construction phase of the Project, there is potential for interactions between two Project components and all three KIs of this VEC. The two Project components are: (i) construction and installation of submarine cables (marine works); and (ii) electrode site preparation and installation. Some of the interactions indicated in Table 14.2.3-3 will occur (e.g., loss of a certain type of Benthic Habitat, changes in benthic community structure, localized increases in turbidity, changes in localized macro-invertebrate and fish distributions) while others are not likely to occur (e.g., changes in seawater and surficial sediment chemistry, changes in specific behaviours and health of macro-invertebrates and fishes).

During the Operations and Maintenance phase of the Project, there is potential for interactions between four Project components and all three KIs of the marine Fish and Fish Habitat VEC. The four Project components are: (i) presence and operation of the transmission system, (ii) routine line inspections and repairs, (iii) potential major system repairs, and (iv) operation of the electrodes. Some of the interactions that are indicated in Table 14.2.3-3 will occur (e.g., introduction of EMF and chlorine to seawater) but most are not likely to occur (e.g., changes in seawater and surficial sediment chemistry, changes in specific behaviours and health of macro-invertebrates and fishes). There would also be interactions associated with major system repairs (e.g., loss of Benthic Habitat, changes in benthic community structure).

14.2.4 Approach to the Environmental Effects Analysis

14.2.4.1 Analytical Methods

Known baseline conditions of the Marine Fish and Fish Habitat VEC were determined using various approaches, including Project-related collection of empirical information through field work (AMEC 2011a, 2010; Sikumiut 2011a, b, c), inclusion of field data collected in the RSA during studies not associated with the Project, review of government databases, and review of primary and grey literature. Various modelling exercises were also conducted to provide quantitative information with which to better assess Project effects on this VEC. The types of Project-related modelling that were conducted include acoustic modelling, electric field modelling, EMF modelling, chemical emission modelling, heat modeling, sediment modelling, and bottom substrate class modelling. The results of the modelling were compared with relevant literature to assess the effects.

Acoustic Modelling

Acoustic modelling was conducted to estimate underwater sound levels from construction activities associated with the submarine cable installation across the Strait of Belle Isle. The modelling involved two studies, both conducted by Jasco Applied Research (Jasco) (2011a, b).

Jasco (2011b) involved the collection of acoustic ambient data during 2010. Using acoustic recorders, data were recorded at three locations along or near the cable crossing corridor from June to August and from September to December. The purpose of the *Strait of Belle Isle: Ambient Noise and Marine Mammal Survey* was to provide a baseline of existing ambient sound in the Strait of Belle Isle during the ice free period.

Table 14.2.3-3 Potential Project Interactions: Marine Fish and Fish Habitat VEC

<table>
<tr><th rowspan="2">Project Component / Activity</th><th colspan="3">Key Indicator</th></tr>
<tr><th>Benthic Habitat</th><th>Marine Water Quality</th><th>Fish</th></tr>
<tr><td colspan="4">Construction</td></tr>
<tr><td>Construction access trails and roads</td><td rowspan="10">–</td><td rowspan="10">–</td><td rowspan="10">–</td></tr>
<tr><td>Movement and presence of personnel, equipment and materials</td></tr>
<tr><td>Construction camps</td></tr>
<tr><td>Marshalling yards and staging areas</td></tr>
<tr><td>Right-of-way clearing and preparation</td></tr>
<tr><td>Quarrying and burrowing</td></tr>
<tr><td>Transmission tower assembly and installation</td></tr>
<tr><td>Conductor installation</td></tr>
<tr><td>Converter station site preparation and construction</td></tr>
<tr><td>Preparation and construction of submarine cable landing sites (on-land works)</td></tr>
<tr><td>Construction and installation of submarine cables (marine works)</td><td rowspan="2">– Direct loss of natural habitat
– Change in health (e.g., sub-lethal and lethal injury) of benthos (primarily fauna, some flora)
– Change in bottom substrate class (possible increase in structural complexity)
– Change in benthic community structure
– Change in surficial sediment chemistry</td><td rowspan="2">– Increase in seawater turbidity
– Change in seawater chemistry
– Change in zooplankton distribution</td><td rowspan="2">– Change in macro-invertebrate and fish distribution
– Change in macro-invertebrate and fish feeding behaviour
– Change in macro-invertebrate and fish reproductive behaviour
– Change in health of macro-invertebrates and fishes</td></tr>
<tr><td>Electrode site preparation and installation</td></tr>
</table>

Table 14.2.3-3 Potential Project Interactions: Marine Fish and Fish Habitat VEC (continued)

<table>
<tr><th rowspan="2">Project Component / Activity</th><th colspan="3">Key Indicator</th></tr>
<tr><th>Benthic Habitat</th><th>Marine Water Quality</th><th>Fish</th></tr>
<tr><td>Island system upgrades</td><td rowspan="4">—</td><td rowspan="4">—</td><td rowspan="4">—</td></tr>
<tr><td>Employment / presence of workers</td></tr>
<tr><td>Contracting / expenditures</td></tr>
<tr><td>System commissioning</td></tr>
<tr><td colspan="4">Operations and Maintenance</td></tr>
<tr><td>Operations / Maintenance access trails and roads</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Presence and operation of the transmission system</td><td>– Introduction of electric field to sediment
– Introduction of EMF to sediment
– Introduction of heat to sediment
– Change in benthic faunal behaviour</td><td>– Introduction of electric field to seawater
– Introduction of EMF to seawater
– Introduction of heat to seawater</td><td rowspan="2">– Change in macro-invertebrate and fish distribution
– Change in macro-invertebrate and fish feeding behaviour
– Change in macro-invertebrate and fish reproductive behaviour
– Change in health of macro-invertebrates and fishes</td></tr>
<tr><td>Routine line inspections and repairs</td><td>– Change in benthic faunal behaviour
– Change in surficial sediment chemistry</td><td>– Increase in seawater turbidity
– Change in seawater chemistry
– Change in zooplankton behaviour</td></tr>
<tr><td>Vegetation management</td><td>—</td><td>—</td><td>—</td></tr>
</table>

Table 14.2.3-3 Potential Project Interactions: Marine Fish and Fish Habitat VEC (continued)

<table>
<tr><th rowspan="2">Project Component / Activity</th><th colspan="3">Key Indicator</th></tr>
<tr><th>Benthic Habitat</th><th>Marine Water Quality</th><th>Fish</th></tr>
<tr><td>Potential major system repairs</td><td>– Direct loss of natural habitat
– Change in health (e.g., sub-lethal and lethal injury) of benthos (primarily fauna, some flora)
– Change in bottom substrate class (possible increase in structural complexity)
– Change in surficial sediment chemistry
– Change in benthic community structure</td><td>– Increase in seawater turbidity
– Change in seawater chemistry
– Change in zooplankton behaviour
– Change in phytoplankton and zooplankton health</td><td rowspan="2">– Change in macro-invertebrate and fish distribution
– Change in macro-invertebrate and fish feeding behaviour
– Change in macro-invertebrate and fish reproductive behaviour
– Change in health of macro-invertebrates and fishes</td></tr>
<tr><td>Operation of the electrodes</td><td>– Introduction of electric field to sediment
– Introduction of EMF to sediment
– Heating of sediment
– Introduction of electrolysis products to sediment
– Change in benthic faunal behaviour
– Change in health (e.g., sub-lethal and lethal injury) of benthos (primarily fauna, some flora)</td><td>– Introduction of electric field to seawater
– Introduction of EMF to seawater
– Introduction of heat to seawater
– Introduction of electrolysis products to seawater</td></tr>
<tr><td>Employment / presence of workers</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Contracting / expenditures</td></tr>
</table>

— No likely or detectable interaction identified.

In addition to collecting baseline data, Jasco prepared *Sound Modelling: Proposed Strait of Belle Isle Cable Installation Activities* (Jasco 2011a) which was undertaken to estimate and describe potential sound levels resulting from the proposed Construction activities associated with underwater cable installation in the Strait of Belle Isle. Acoustic propagation from five activities were considered: (i) Horizontal Directional Drill (HDD) (from on-land at Forteau Point, Labrador and Shoal Cove, Newfoundland and out under the Strait), (ii) transit of cable-laying vessel, (iii) operations of cable-laying vessel in dynamic positioning mode, (iv) transit of rock-placement vessel, and (v) operations of rock-placement vessel in dynamic positioning mode. Vessel transit and operations were modelled at four locations along the cable crossing corridor. The sound propagation model used acoustic parameters specific to the geographic region of interest, including water column sound speed profile, bathymetry and bottom geoacoustic properties, to produce site-specific estimates of the radiated noise field as a function of range and depth. The acoustic footprint and maximum distance (range) to underwater sound pressure level isopleths between 200 to 120 decibels (dB) re 1 microPascal (µPa) root mean square (rms) were determined for each activity. Further, the predicted sound levels were compared with the ambient noise level values measured as part of *Strait of Belle Isle: Ambient Noise and Marine Mammal Survey* (Jasco 2011b). The loudest source per modelling site was considered for comparison. The quietest, 95th percentile ambient noise spectrum, was selected as the baseline.

Electric Field Modelling

The electric field created by the electrodes is a function of the Ground Potential Rise (GPR) gradient. The GPR gradient model uses two inputs to model the difference in voltage predicted at various distances from an electrode site: (i) the resistivity (i.e., how strongly a material opposes the flow of electric current) of the geological units and of the seawater surrounding the electrode; and (ii) the electrode current at nominal levels during normal bipolar operations (e.g., less than (<) 1 percent (%) of the current) and during monopolar operations (e.g., 100% of the current). Hatch Ltd. (Hatch 2011) modelled the GPR gradient at various distances from the electrode to determine the electric field produced under normal bipolar operations and during monopolar operations. Hatch Ltd. (2011) conducted modelling at two voltages, 320 kV and 400 kV as 'book end' scenarios for the operating parameters for the Project as the system voltage had not yet been finalized.

The electric field around the submarine cables was also calculated using the design specifications of the cable (e.g., the armour layers and the protective rock berm).

Electromagnetic Field Modelling

Magnetic fields are produced by the flow of current through cables and conductors, and also as electric current passes through other media such as the sea and soil. The magnitude of the magnetic field at a given point is dependent on the distance from the conductor, and the permeability of the medium. Hatch Ltd. (2011) modelled the EMF for both electrode sites for electrode current at nominal levels during normal bipolar operations (e.g., <1% of the current) and during monopolar operations (e.g., 100% of the current). The EMF modelling is based on the GPR gradient model used for the electric field modelling. The EMF modelling was calculated at the surface as this represents the worst-case for EMFs, as they decrease with depth in the present situation.

Hatch Ltd. (2011) conducted modelling at two voltages, 320 kV and 400 kV as 'book end' scenarios for the operating parameters for the Project as the system voltage had not yet been finalized.

The EMF around the submarine cables was also calculated with consideration of the design specifications of the cable (e.g., the armour layers and the protective rock berm) at various distances from the cable using the Bio-Savart formula (Worzyk 2009).

Chemical Emission Modelling

When current is added to seawater, electro-chemical reactions can occur. The two main gases associated with electrode operation in the marine environment are hydrogen by the cathode, and chlorine by the anode. Hatch Ltd. (2011) calculated the amount of these gases that would be produced at both electrode sites, operating as an anode and as a cathode. As the amount of current passing through the electrode determines the amount of product that results from the reaction, the calculations were carried for two operating conditions: (i) during normal bipolar operations at nominal levels (e.g., <1% of the current) and; (ii) during monopolar operations (e.g., 100% of the current). The concentration of products were calculated, and considered the saltwater pond volume, tidal flushing, and local marine environmental conditions (e.g., temperature, pH).

Heat Modelling

When current is added to water, the dissipation of energy may occur in the form of heat. Heat loss calculations were performed for both electrode sites and were carried out for two operating conditions: (i) during normal bipolar operations at nominal levels (e.g., <1% of the current) and; (ii) during monopolar operations (e.g., 100% of the current). The worst case dissipation through the seawater density was calculated through the berm, between the saltwater pond and the sea. Estimated maximum temperature rise in the saltwater pond was calculated under monopolar operations.

The heat dissipated by the HVdc cables was also calculated. Specifically, the heat output was calculated using $P = I^2*R$, which = $(1,400)^2*(0.015 \text{ ohm/km})$ = 29.4 Watts for every metre of cable.

Sediment Modelling

A sediment modelling study, *Strait of Belle Isle: Oceanographic Environment and Sediment Modelling* (AMEC 2011b), was completed to model the likely characteristics of sedimentation that may occur as a result of marine Construction activities associated with the Strait of Belle Isle submarine cable crossing. The study involved the creation of a hydrodynamic model to simulate the current fields and other hydrodynamic processes (such as water elevation). The water current fields output of the hydrodynamic model was then used to simulate the dispersion of the sediment material that may be released as a result of the Construction activities associated with the marine cable installation in the Strait of Belle Isle. The hydrodynamic model was based on bathymetric data previously acquired by Nalcor and forced by tidal water level variations. Tidal measurements were obtained from four tidal gauges installed in the Strait of Belle Isle specifically for this study. A tide-only simulation was performed initially and then validated against historical data. A second simulation of water currents associated with the Strait as a result of atmospheric forcing was conducted using information from the scientific literature. Overall, the output and validation process was successful and demonstrated the ability of the model to reproduce water level and water current fluctuations associated with tides and atmospheric forcing.

The Fisheries and Oceans Canada (DFO) sediment dispersion particle tracking Benthic Boundary Layer Transport (BBLT) model (Drozdowski 2009; Drozdowski et al. 2004) was used to simulate the dispersion of sediment material (particles) within the Strait of Belle Isle. The model used information from surficial sea-bottom survey results previously acquired by Nalcor and the output of the hydrodynamic tidal simulation. Available information regarding the Construction activities in the marine environment (i.e., rock placement) was also compiled to provide a hypothetical scenario of bottom sediment release.

Bottom Substrate Class Modelling

In 2007, Fugro Jacques GeoSurveys Inc. (FJGI), on behalf of Nalcor, conducted geophysical surveys of approximately 28 square kilometres (km^2) of seafloor in the Strait of Belle Isle within which the preliminarily identified proposed submarine cable crossing corridors would occur. Initially, a regional multi-beam echosounder survey was conducted to identify two 500 m wide potential submarine cable corridors extending across the Strait of Belle Isle. Then detailed geophysical surveys using side-scan sonar, sub-bottom profiler and multi-beam echosounder were conducted on the two corridors to characterize the bathymetric and seafloor surficial geological conditions (FJGI 2010).

In 2008, AMEC Earth and Environmental conducted a ground-truthing video survey of the preliminary two submarine cable crossing corridors. The survey resulted in high quality underwater video footage of approximately 84% (52 kilometres (km)) of the total length of the two submarine cable corridors. The video was used to identify and categorize the types of seafloor substrate within the two corridors, as well as document the presence, abundance and distributions of various marine fauna and flora (AMEC 2010).

The 2007 geophysical survey imagery was then reviewed, analyzed and interpreted using the information collected during the 2008 video survey to guide and inform the interpretation, specifically to identify, categorize and map the seafloor substrate and bathymetry within the preliminary two submarine cable crossing corridors (FJGI 2010).

After the 2007 and 2008 surveys were conducted, the final, proposed submarine cable crossing corridor was selected. This corridor incorporates portions of the two corridors surveyed in 2007 and 2008 as well as a new 8 km section on the Newfoundland terminus. Recently, the geophysical and video survey information that pertains only to the proposed submarine cable crossing corridor was extracted from the original databases (FJGI 2011; AMEC 2011a). In early 2011, a video survey was conducted on the new section of the Strait of Belle Isle submarine cable crossing corridor (Sikumiut 2011c). However, there is not any corresponding sonar imagery for this new section so the type of interpretation completed for the 2007 geophysical data using the 2008 video survey data to guide and inform the interpretation does not apply to the new 8 km long section of the submarine cable crossing corridor.

14.2.4.2 Marine Fish and Fish Habitat VEC Effects Analysis

The Marine Fish and Fish Habitat VEC effects analysis uses a structured and rigorous approach that includes an appropriate combination of quantitative and qualitative methods. The analysis considers the nature and degree of likely Project-induced effects from the existing environment (baseline conditions). Once the Project components and activities are overlaid onto the Marine Fish and Fish Habitat VEC and potential interactions are identified, then mitigation can be applied to avoid or minimize the effects that could result from the interactions (i.e., residual effects). The effects assessment is based on the Project with mitigation in place. Descriptors to be used in the residual effects analysis are discussed in the following section.

14.2.4.3 Environmental Effects Descriptors

Five descriptors are used to assess the residual effects of the Project on the Marine Fish and Fish Habitat VEC: (i) direction; (ii) magnitude; (iii) geographic extent; (iv) duration; and (v) frequency. Each descriptor is characterized by at least three ratings that provide further clarification of the descriptor of any particular residual effect. The definitions of the ratings of environmental residual effects descriptors for the Marine Fish and Fish Habitat VEC are provided in Table 14.2.4-1. The definitions apply to all three KIs of this VEC.

Table 14.2.4-1 Effects Descriptors: Marine Fish and Fish Habitat VEC

Effects Descriptor	Definition
Direction	
Adverse	Undesirable effect on KI
Neutral	No effect on KI
Beneficial	Desirable effect on KI
Magnitude	
Low	Effect on KI within normal range of variability
Moderate	Effect on KI unlikely to pose serious risk or represent management challenge
High	Effect on KI likely to pose serious risk and represent management challenge
Geographic Extent	
Local	Effect on KI limited to the Local Study Area
Regional	Effect on KI limited to the Regional Study Area
Beyond Regional	Effect on KI extends beyond the Regional Study Area
Duration	
Short-term	Effect on KI persists for less than or equal to (≤)1 year
Medium-term	Effect on KI persists for greater than (>)1 to ≤4 years

Table 14.2.4-1 Effects Descriptors: Marine Fish and Fish Habitat VEC (continued)

Effects Descriptor	Definition
Long-term	Effect on KI persists for >4 to ≤30 years
Far future	Effect on KI persists for >30 years
Frequency	
Low	Effect on KI occurs not more than once per year
Moderate	Effect on KI occurs 2 to 10 times per year
High	Effect on KI occurs more than 10 times per year
Continuous	Effect on KI is continuous

14.2.5 Construction

14.2.5.1 Overview of Project Construction and Associated Effects Management

Project Construction activities that are most relevant to the Marine Fish and Fish Habitat VEC include placement of the underwater rock berms to protect the submarine cables, placement of the rock berms associated with the shoreline electrode sites, dredging at shoreline electrode sites, and noise created by a variety of Project Construction activities (e.g., marine vessels, drilling, dredging).

Compensation works approved by DFO will mitigate the direct loss of marine fish habitat caused by rock placement, dredging and use of the saltwater pond at the L'Anse au Diable shoreline electrode site. In the case of rock placement the surface area and interstitial spaces of the berms will function as fish habitat albeit habitat characterized by a bottom substrate class different from that of the natural habitat in some locations.

Other mitigation measures of the Project Construction phase that Nalcor will employ to minimize effects on the Marine Fish and Fish Habitat VEC include:

- controlled rock placement with a fall pipe will be employed to minimize the amount of natural habitat coverage (i.e., direct loss of habitat);
- cable corridor will not be swept prior to cable installation;
- chemically-benign rock will be used for berm construction to minimize the effect on seawater and surficial sediment chemistry;
- construction time will be minimized to decrease the amount of exposure to vessel noise by invertebrates and fishes;
- drill mud will be recovered from the bore holes and conduit to the extent possible;
- drill mud will be recycled and the cuttings will be disposed of on land;
- silt curtains will be deployed during electrode site dredging to minimize the extent of increased turbidity;
- biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies;
- proper protocols will be implemented to avoid accidental introduction of potentially deleterious substances to the marine environment including all applicable regulations to minimize effect on seawater and surficial sediment chemistry;
- spill kits and trained personnel will be present on-site at all times, allowing for prompt containment;

- a spill response team will be formed and trained;
- spills will be reported to the appropriate authority;
- fuelling or serving or mobile equipment on-land will not be permitted within 50 m of a waterbody;
- the SHERP (Safety, Health and Environment Emergency Response Plan) will contain spill prevention and response plan; and
- the EPP (Environmental Protection Plan) will contain conditions for fuel handling and storage, including procedures for spill response.

The potential effects of the underwater construction of berms, pipelines, and underwater cables are relatively well known from many hundreds of projects worldwide. Key references relating to the effects of Construction activities of similar projects on Marine Fish and Fish Habitat are included in Table 14.2.5-1 along with summary text on project context and study findings for each reference.

Table 14.2.5-1 Existing Knowledge (Construction): Effects of Similar Projects on the Marine Fish and Fish Habitat VEC

Reference	Study / Project Context	Summary of Findings
Andrulewicz et al. 2003	– Study of environmental effects of installation of SwePol Link High Voltage direct current (HVdc) submarine transmission cable in the Baltic Sea	– No significant changes in zoobenthos species composition, abundance or biomass as a result of cable installation
Emu Ltd. 2004 *in* OSPAR 2008	– Environmental appraisal of subsea cable decommissioning	– Comprehensive review concluded that mobile species are able to avoid bottom disturbance and survive – Comprehensive review concluded that faunal communities occurring on exposed bedrock, gravel, and sand substrate are more prone to long-term (>6 months) damage than are those occurring on clay and mobile sand substrate
Söker et al. 2000 *in* OSPAR 2008	– Reviewed substrate disturbance and turbidity effects of cable laying	– Estimated that cable laying could disturb a 2 m wide sector on either side of the cable, thereby increasing turbidity in the water several metres from the cable laying location – Concluded that effects on the water were diminished after a period of hours whereas effects on the sea bottom might be observable for several weeks

14.2.5.2 Construction Effects: Benthic Habitat

The activity associated with the Construction and installation of the submarine cables and construction of the shore electrode site that will have three immediate effects on Benthic Habitat is placement of rock during construction of the protective berms covering the submarine cables. The three immediate effects are: (i) naturally occurring bottom habitat will be covered by the rock berms and made inaccessible to many floral and faunal species; (ii) some flora and fauna occurring on the portion of the sea bottom covered by the rock berms and dredging at the Dowden's Point shore electrode site will be either injured or killed; and (iii) the proportions of the various bottom substrate classes of the rock berm footprint will change. Another effect of the placement of the rock berms will be a change in the benthic community structure within the berm footprint but this change will not be evident immediately. There is also potential for construction activities to cause changes in surficial sediment chemistry if there are accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons).

Berm construction rock placement and dredging during shoreline electrode site preparation and installation will cause the same three immediate effects and one delayed effect on the Benthic Habitat discussed above. As with activities associated with cable installation, there is the potential effect of shoreline electrode site preparation and installation to change the surficial sediment chemistry as a result of accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons). This effect has greater likelihood of occurring during the electrode site preparation and installation because of the relatively shallow water conditions compared to the Strait of Belle Isle rock berm footprint.

Direct Loss of Natural Habitat

The three rock berms that will protect the submarine cables crossing the Strait of Belle Isle are designed to be 8 to 12 m wide, and 0.8 m to 1.5 m high. Based on a 12 m width and an approximate 30 km length, each rock berm will cover about 360,000 square metres (m^2) (0.36 km^2) of natural bottom substrate. Therefore, about 7% of the Strait of Belle Isle LSA Component natural bottom habitat will be covered by the rock berms. Controlled rock placement with a fallpipe will be employed to minimize the amount of overburden coverage. At the same time, based on the proposed berm design, the ratio of berm surface area to area of covered natural substrate is 1.057:1, which translates to the creation of at least 380,520 m^2 (0.38 km^2) of new bottom substrate, some of which is more structurally complex than that covered by the berm. This will result in about 20,500 m^2 more bottom substrate than was present prior to berm construction.

The permeable rock berms that will be constructed at each electrode site will also cover natural substrate and, at the same time, provide substrate with increased surface areas. However, only a portion of the breakwater berms will be submerged so the ratio of berm surface area available to marine biota to the area of covered natural substrate will likely be less than that calculated for the Strait of Belle Isle berms. The amount of marine fish habitat that will be affected by dredging at the electrode sites is still unknown, but limited to the shoreline electrode sites. The total footprint of the L'Anse au Diable shoreline electrode site, including the protective berm and inside 'saltwater pond' will be about 31,100 m^2. The total footprint of the Dowden's Point shoreline electrode site, including the protective berm and outside dredge area will be about 8,250 m^2.

The HDD bore exit hole diameter will be 50 to 55 centimetres (cm). Three bore holes will be drilled at each end of the submarine cable crossing corridor. Therefore, the area of natural bottom substrate that will be affected when the drill breaks through to the marine environment is about 0.75 m^2 at either end of the submarine cable crossing corridor. All drill mud will be recovered from the bore holes and conduit to the extent possible. The mud itself will be recycled and the cuttings will be disposed of on land.

The sediment modelling for the Project supports the prediction that deposition of re-suspended sediment resulting from construction activities will be minimal. S*trait of Belle Isle: Oceanographic Environment and Sediment Modelling* (AMEC 2011b) concluded that the maximum thickness of material likely deposited was found to be small with values ranging from about 0.1 mm to a maximum of 1.5 mm.

Therefore, smothering effect of deposited re-suspended sediments or drill muds are not an issue of direct loss of natural habitat with the Project.

Change in Health of Benthos

Placement of rock during the construction of the Strait of Belle Isle and electrode site berms, and dredging at the Dowden's Point electrode site will affect the health of the benthos upon which rock is deposited and that removed during dredging. As is the case with the bottom habitat discussed above, the benthos that will experience health effects represent a small proportion of all benthos in the LSA.

Change in Bottom Substrate Class

Changes in the relative proportions of bottom substrate classes at some rock placement locations are likely to result from the Construction activities of the Project. The size range of the rock that will be used to construct the cable berms is 50 millimetres (mm) to 200 mm. This size range equates to a mixture of Coarse-Small (cobble) and Coarse-Large (rubble) substrate classes. Most of the external surface areas of the cable berms will consist of Coarse-Large (rubble). The dominant substrate class found in the portion of the submarine cable crossing corridor that has been analyzed is Coarse-Small (60.47%), followed by Coarse-Large (15.61%) (FJGI 2011).

The size range of the rock to be used for the permeable berms for the electrode sites will be larger in the permeable zone and is anticipated to be 0.5 m to 1 m in diameter. The dominant substrate class found at the area of the L'Anse au Diable shoreline electrode site which will be covered by the breakwater berm is Fine (sand), followed closely by Bedrock/Coarse-Large (bedrock and boulder). The dominant substrate class found at the area of the Dowden's Point shoreline electrode site which will be covered by the breakwater berm and dredged to the 4 m depth is Coarse-Large/Coarse-Small (boulder and cobble). The greatest change in substrate class will occur at the western end of the breakwater berm at the L'Anse au Diable shoreline electrode site where the dominant naturally occurring substrate is sand. The addition of cobble and rubble to this area will likely increase the physical complexity of the habitat accessible to epibiota.

Change in Benthic Community Structure

The overall effect of the three preceding effects is change in benthic community (i.e., both flora and fauna) structure as a result of colonization of the created rock berm habitat, which is essentially an artificial reef. There are numerous studies that support the use of rock as a suitable substrate for the colonization of sessile, encrusting marine life, especially if the individual rocks are irregularly shaped. This results in increased surface area, both on the surface of the reef as well as inside the reef (Steimle et al. 2002; Wendt et al. 1989). Rates of colonization are dependent on numerous factors including water depth, nature of surrounding natural habitat, and oceanographic conditions at the reef. Naturally, if the constructed reef represents different bottom substrate classes than the naturally occurring habitat, the benthic community that establishes itself on the reef will likely be characterized by different floral and faunal species.

Change in Surficial Sediment Chemistry

Unintentional releases of chemicals (e.g., hydrocarbons) to the marine environment during Project Construction activities could result in localized changes to surficial sediment chemistry which in turn could potentially cause adverse effects on the health of biota coming into contact with the affected sediment. Changes to surficial sediment chemistry could also occur as a result of bottom disturbance and re-suspension of existing sediments. However, there are no indications from baseline sediment chemistry data that contaminated sediments occur within the LSA (Sikumiut 2011a, b, c; Sikumiut 2010a, b).

Assessment of Construction Effects on Benthic Habitat

The likely residual effects of Project Construction on the Benthic Habitat KI are as follows:

- Initially adverse because of the immediate loss of natural bottom habitat and sub-lethal / lethal physical effects on benthic biota. Over time, colonization of the more structurally complex rock berms and the electrode site dredge areas will off-set the initial adverse effect of rock placement and dredging.
- Low to moderate magnitude because the amount of affected Benthic Habitat will likely represent a small proportion of similar Benthic Habitat in the LSA.
- Limited to the LSA.
- Short- to medium-term duration because the altered habitat will be rapidly re-colonized (i.e., 1 to 2 years) and likely be characterized by a similar level of productivity.
- Low in frequency as the placement of rock berms and dredging will occur only once during the Construction phase.

There is a high degree of confidence that the level of effect will not be greater than predicted. Little supposition is associated with these residual effects. Dimensions of the berm and dredge areas are known, and can be readily expressed as a percentage of the LSA. There is also a substantial amount of literature related to marine artificial reefs that support the concept of re-colonization and re-establishment of productivity.

14.2.5.3 Construction Effects: Marine Water Quality

Activities associated with the construction and installation of the submarine cables will likely cause only one effect on the Marine Water Quality KI: increased seawater turbidity. The turbidity change will also likely occur during construction of the rock berms at the L'Anse au Diable and Dowden's Point electrode sites and during dredging at the Dowden's Point electrode site. The HDD could also cause increased turbidity when the drill breaks through the bottom substrate at either end of the submarine cable corridor. Potential effects of construction / installation / preparation activities on Marine Water Quality include changes in zooplankton distributions due to exposure to noise, and changes in the seawater chemistry if potentially deleterious substances are accidentally introduced to the marine environment.

The activity associated with the construction and installation of the submarine cables that will have the greatest effect on Marine Water Quality is placement of rock during construction of the protective berms covering the submarine cables. The primary effect of this activity will be the re-suspension of bottom sediments, resulting in increased seawater turbidity. A secondary effect of rock placement and other submarine cable construction and installation activities such as vessel transit, cable laying and drilling is the introduction of additional underwater sound to the marine environment. Zooplankton, a component of the Marine Water Quality KI, is known to react to underwater sound. There is also potential for the submarine cable construction and installation to cause changes in seawater chemistry if there are accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons).

Berm construction rock placement and dredging during shoreline electrode site preparation and installation will also cause re-suspension of bottom sediments and introduction of additional underwater sound to the marine environment. As with the submarine cable construction and installation, the electrode site preparation and installation could also change the seawater chemistry as a result of accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons).

Increase in Seawater Turbidity

Turbidity is defined as the measure of the attenuation of light in the water column, and can be caused by the light adsorption properties of the water, plankton, suspended particulate organic and inorganic matter, and dissolved colour. The degree and duration of turbidity change will depend on various factors including the nature of the substrate, duration of the disturbing activity, tidal cycle, and water depth. Direct effects of high levels of turbidity in the water column include:

- reduction in phytoplankton biomass;
- reduction in growth rates, areal coverage and depth of colonization of macroflora; and
- negative effects on benthic invertebrate communities and fishes (U.K. Marine SACs Project 2011, internet site).

Suspended sediments are often the primary contributors to turbidity. They are typically silt and clay particles measuring two to 60 micrometres (µm) in diameter. They are often measured directly as total suspended solids (TSS) in milligrams per litre (mg/L) or indirectly as turbidity (Parr et al. 1998).

Elevated TSS conditions have been reported to cause physiological stresses, growth reduction, and lower survival. It is important to consider the frequency and duration of exposure to increased TSS and not just the TSS concentration. The effects of elevated TSS conditions also vary depending on the species and its life history stage being affected (Wilber and Clarke 2001). Elevated TSS conditions can affect marine invertebrates and / or fish in the following ways:

- behavioural effects including avoidance, attraction, reduced feeding success, and increased 'gill flaring';
- physical effects including stress, tissue damage, reduced growth, and mortality; and
- habitat effects including increased sedimentation, filling of gravel interstitial spaces, decrease in gravel inter-particle dissolved oxygen concentration.

Wilber and Clarke (2001) conducted a review of suspended sediment effects on fish and shellfish in relation to dredging activities in estuaries. Unlike the attention that has been given to suspended sediment effects on salmonid fish, relatively little is known about the effects on estuarine fish and invertebrates. However, studies of the effects of suspended sediments on various marine species have been conducted. Biota studied includes bivalve eggs, larvae and adults (Davis 1960; Davis and Hidu 1969; Mulholland 1984; Hawkins et al. 1996). Primary mechanisms used by bivalves to deal with higher than usual concentrations of suspended sediment include reduction of net pumping rates (Foster-Smith 1976), rejection of excess filtered material as pseudofeces (Hawkins et al. 1996), and reduced growth and survival (Kirby 1994). Eggs and larvae of non-salmonid estuarine fish exhibit some of the most sensitive responses to suspended sediment exposure. Behavioural responses to, and sub-lethal and lethal physical effects of suspended sediment has also been observed for several estuarine fish species (Wilber and Clarke 2001).

Based on baseline study results (Sikumiut 2011a, b, c; FJGI 2011; AMEC 2011a; FJGI 2010; AMEC 2010a, b), substrate finer than sand (e.g., mud, silt) in the LSA is negligible, with the exception of the western portion of the L'Anse au Diable LSA Component. Therefore, substrate conditions in the LSA are not conducive to re-suspension of sediments during rock placement, dredging and drilling.

The sediment modelling for the Project also supports the prediction that re-suspension of sediment resulting from Construction activities will be spatially and temporally limited. *Strait of Belle Isle: Oceanographic Environment and Sediment Modelling* (AMEC 2011b) presented the following key results from the sediment dispersion model:

- following the rock placement activities, suspended sediment concentrations over 100 mg/L were found to occur within a few hundred metres of the activity location; and
- duration of elevated suspended sediment concentration (over 100 mg/L) was found to range from 1 hour for various locations along and near the corridor over an area of 10.9 km^2, and up to 100 hours or more for fewer locations totalling 1.3 km^2 in area.

Change in Zooplankton Distribution

The behavioural effects of exposure to underwater sound on various marine animals are issues / questions which have been raised in relation to the Project. Some understanding of the fundamentals of underwater sound is required to enable assessment of effects.

Background Information on Underwater Sound

Most treatments of the effects of underwater sound are based on the Source-Path-Receiver concept. In the case of the Project, there are several sound sources (e.g., marine vessels, drilling, dredging). Seawater is an efficient medium through which sounds can travel long distances and represents the path. The receiver of these sounds is a marine animal of interest. The sounds received are dependent on the amount of propagation loss that occurs between the source and the receiver. The ability of the receiver to detect these signals depends on the hearing capabilities of the species in question, as well as the amount of ambient or background noise in the sea around the receiver. The sea is a naturally noisy environment, and the ambient noise can mask weak signals from distant sources (Richardson et al. 1995).

Acousticians use a logarithmic scale for sound intensity and denote the scale in dB. In underwater acoustics, sound is usually expressed as a Sound Pressure Level (SPL):

$$\text{Sound Pressure Level} = 20 \log (P/Po)$$

P represents the pressure and Po is a reference level, usually 1 µPa. As other reference levels have also been used in the past, the reference level needs to be shown as part of the SPL unit. In this scale, a doubling of the sound pressure means an increase of 6 dB. For example, a pressure (P) of 1,000 Pascals (Pa) has an SPL of 180 dB re 1 µPa whereas a pressure of 500 Pa has an SPL of 174 dB re 1 µPa. To interpret quoted SPLs, one must also have some indication of where the measurement applies. SPLs are usually expressed as either received sound levels at the receiver location or as sound levels at the source. A source level is usually calculated or measured as the SPL at 1 m distance from the source. The SPL can be expressed in different metrics: the difference in pressure between the highest positive pressure and the lowest negative pressure is the peak-to-peak pressure (p-p). The peak positive pressure, usually called the peak or zero to peak pressure (0-p), is approximately half the peak-to-peak pressure. The average pressure recorded during the pressure pulse can be expressed as the rms or average pressure. The rms pressure is integrated over the duration of the sound signal. A difficulty with this type of measurement is that it is often hard to interpret because it depends on the averaging time.

More recently, some sounds have been measured as Sound Exposure Levels or SELs. This is directly proportional to the total energy density of the acoustic signal. Energy is proportional to the time integral of the pressure squared. Hence, SEL includes time as a dimension and is expressed as μPa^2-s. Energy levels are not directly comparable to pressure levels. In most cases, energy values are less than “average pressure squared over the pulse duration”, measured in dB re 1 µPa, but the difference is variable. As most of the literature on effects of sound on marine animals is presented as SPLs, the discussion in this EIS focuses on pressure levels (Richardson et al. 1995).

Sound measurements are often expressed as broadband, meaning the overall level of the sound over a range or band of frequencies. The level at a specific frequency will be lower than the broadband sound level for some bands containing that frequency because the broadband sound includes the components over a wide range of frequencies. Sound signatures consist of measurements of the sound level at each frequency (a sound spectrum). Sound level can also be measured and summed over groups or bands of frequencies (e.g., octaves or third octaves) (Richardson et al. 1995).

The other component of underwater sound to which invertebrates and fishes are sensitive is particle displacement.

Zooplankton Behavioural Responses to Underwater Noise

While there is limited published literature related to marine invertebrate behavioural responses to underwater noise (see Section 14.2.5.4), none directly considers zooplankton. Some work has been done on marine benthic invertebrate larvae and these studies would be most relevant to zooplankton. For example, a recent study concluded that coral larvae can detect and respond to sound, the first description of an auditory response in the invertebrate phylum Cnidaria (Vermeij et al. 2010). Other work has investigated the use of underwater sound by pelagic crustacean stages (Jeffs et al. 2005, 2003).

Sound Modelling

Ambient underwater sound levels at three locations in the Strait of Belle Isle were measured during June to August and September to December 2010. The modelling concluded that ambient sound levels at all stations were most affected by vessel traffic and tidal flow. The average ambient sound level at the Middle Station was 5 dB higher during September to December than during June to August, likely due to increased wind speeds during the fall months. During June to August, the highest ambient sound levels were in the 10 to 100 Hz band, ranging from about 100 to 140 dB re 1µPa_{rms} (Jasco 2011b).

The underwater sound associated with cable installation activities were also modelled (Jasco 2011a). The rock placement vessel in dynamic positioning mode is expected to produce the largest ensonified area and have a range radius to 120 dB re 1µPa_{rms} of 11,615 m, the longest of all sources modelled. The range radii to 120 dB re 1µPa_{rms} of the other sources, in descending order, are 8,900 m for the cable laying vessel in dynamic positioning mode, 5,000 m for the rock placement vessel in transit, and < 2,000 m for the cable laying vessel in transit and the HDD. Dominant frequency ranges determined by modelling are 1.3 to 1.6 Hz for the HDD, 40 to 80 Hz for transiting vessels, and 400 to 800 Hertz (Hz) for the vessels in dynamic positioning mode. The modelling also identified broadband sound levels as much as 50 dB above ambient as far as 14 km from the sound source.

Based on the available information related to marine invertebrate behavioural responses to underwater sound and results of the sound modelling in the Strait of Belle Isle, the underwater sound generated by Project Construction activities could potentially cause shifts in local distributions of zooplankton. However, these effects would be both temporally and spatially limited, especially considering that invertebrates are thought to respond only to the particle motion part of underwater sound.

Change in Seawater Chemistry

Unintentional releases of chemicals (e.g., hydrocarbons) to the marine environment during Project Construction activities could result in localized changes to seawater chemistry which in turn could potentially cause adverse effects on the health of biota coming into contact with the affected seawater. Changes to seawater chemistry could also occur as a result of bottom disturbance and re-suspension of existing sediments. However, there are no indications from baseline sediment chemistry data that contaminated sediments occur within the LSA (Sikumiut 2011a, b, c; Sikumiut 2010a, b).

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on the Marine Water Quality KI are as follows:

- Adverse because of the high likelihood of increased seawater turbidity and associated change in seawater chemistry at locations along the submarine cable crossing corridor during berm construction, and at the L'Anse au Diable and Dowden's Point shoreline electrode sites during dredging;
- Low to moderate magnitude because the volume of affected seawater is likely to represent a small proportion of seawater in the LSA and to not pose serious risk to the KI;
- Limited to the LSA or just beyond the LSA boundary into the RSA;
- Short-term duration because the material suspended in the seawater will resettle on the sea bottom within 1 to 100 hours and affected seawater chemistry will return to ambient state through dilution; and
- Low in frequency as the placement of rock berms and dredging will occur only once during the Construction phase.

There is a high degree of confidence that the level of construction activity effect on Marine Water Quality will not be greater than predicted. This degree of confidence is supported by the rigor of the sediment modelling (AMEC 2011b), the collected baseline data related to the substrate characteristics (Sikumiut 2011a, b, c; AMEC 2011a, 2010; FJGI 2011, 2010), the sound modelling (Jasco 2011a, b), and available scientific literature.

14.2.5.4 Construction Effects: Fish

Activities associated with the construction and installation of the submarine cables, and preparation and installation of the electrode sites will result in at least two effects on the Fish KI: (i) the introduction of additional underwater sound to the marine environment causing behavioural changes in macro-invertebrates and fishes and (ii) sub-lethal and lethal physical effects on some macro-invertebrates and fishes due to rock placement during berm construction and dredging. Both activities will affect the health of these animals by direct disruption as well as through re-suspension of sediments. Behavioural responses will likely result in slight changes of local distributions of these animals. However, effects on feeding and reproductive behaviours can be considered more tenuous. Effects on feeding and reproductive behaviours would most likely be associated with shoreline electrode construction activities considering the relatively shallow water conditions at these sites. There is also potential for the construction and installation activities to cause changes to the health of macro-invertebrates and fishes if there are accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons).

Change in Macro-invertebrate and Fish Distribution, Feeding Behaviour and Reproductive Behaviour

The behavioural effects of exposure to underwater sound on various marine animals are issues / questions which have been raised in relation to the Project. Some background on the fundamentals of underwater sound is required to enable assessment of effects.

Macro-invertebrates

The hearing abilities of marine invertebrates are the subject of ongoing debate. It appears that marine invertebrates respond to vibrations rather than the pressure component of sound (Breithaupt 2002). Statocyst organs (an organ of balance containing mineral grains that stimulate sensory cells as the animal moves) apparently function as a vibration detector for at least some species of marine invertebrates (Popper and Fay 1999).

Among the marine invertebrates, decapod crustaceans have been the most intensively studied. Crustaceans appear to be most sensitive to low frequency sounds (i.e., <1000 Hz) (Popper et al. 2001; Budelmann 1992). Other studies suggest that some species, such as the American lobster, may also be sensitive to frequencies higher than previously reported (Pye and Watson III 2004).

Cephalopds also use statocysts to detect low-frequency aquatic vibrations (Budelmann and Williamson 1994). Kaifu et al. (2008) provided evidence that the cephalopod *Octopus ocellatus* detects particle motion with its statocyst. Studies by Mooney et al. (2010), Komak et al. (2005), Rawizza (1995) and Packard et al. (1990) have quantified sound frequencies to which various octopus (1 to 100 Hz), squid (1 to 500 Hz), and cuttlefish (20 to 8,000 Hz) species are most sensitive.

It is generally accepted that low level underwater sound has little likelihood of causing any significant physical effects on marine invertebrates. Behavioural effects of exposure to underwater sound are now the primary focus. The limited study of this topic has identified alarm / startle responses by cephalopods (Komak et al. 2005; McCauley et al. 2000a, b) and changes in feeding behaviour by shrimp (Lagardère 1982) and American lobster (Payne et al. 2007). Note that in all cases the exposed animals were captive during exposure which makes extrapolation to open environments difficult. Other studies investigating potential behavioural effects of exposure to underwater sound on marine invertebrates have not observed any effects (Christian et al. 2003). Behavioural effects have also been investigated by considering changes in invertebrate catchability during directed fisheries (Parry and Gason 2006; Andriguetto-Filho et al. 2005; Christian et al. 2003). None of the studies observed any changes in catch per unit effort.

Anecdotal information from Newfoundland indicated that catch rates of snow crab demonstrated a significant reduction immediately following a pass by a seismic survey vessel (Chidley 2000, pers. comm.). Additional anecdotal information from Newfoundland indicated that a school of shrimp observed via a fishing vessel sounder shifted downwards and away from a nearby seismic airgun sound source (Thorne 2002, pers. comm.). The observed effects were temporary.

In summary, documented information relating to behavioural responses of marine invertebrates to underwater sound is limited. The information that is available suggests that behavioural responses observed are temporary but there remains some uncertainty regarding their biological significance.

Fishes

Marine fishes demonstrate considerable variability in sensitivity to underwater sound. Although hearing sensitivity data exist for fewer than 100 of the 27,000 fish species (Hastings and Popper 2005), current data suggest that most species of fish detect sounds below 1500 Hz (Popper and Fay 2011). Some marine species, such as shads and menhaden, can detect sounds above 180 kHz (Mann et al. 2001, 1998, 1997). Also, at least some species are acutely sensitive to infrasound, down to below 1 Hz (Sand and Karlsen 2000). Reviews of fish-hearing mechanisms and capabilities can be found in Fay and Popper (2000) and Ladich and Popper (2004).

Researchers have noted that fish without an air-filled cavity (swim bladder), or with reduced swim bladders or limited connectivity between the swim bladder and inner ear, are limited to detecting particle motion and not pressure, and therefore have relatively poor hearing abilities (Casper and Mann 2006). These species have commonly been known as 'hearing generalists' (Popper and Fay 1999), although a recent reconsideration suggests that this classification is oversimplified (Popper and Fay 2011). Rather, there is a range of hearing capabilities across species that is more like a continuum, presumably based on the relative contributions of pressure to the overall hearing capabilities of a species (Popper and Fay 2011). Results of direct study of fish sensitivity to particle motion have been reported in numerous recently published papers (Kojima et al. 2010; Wysocki et al. 2009; Horodysky et al. 2008).

As with invertebrates, the effect of exposure to underwater sound on fishes of most concern is behavioural in nature. Fishes exhibit a variety of behavioural responses in reaction to underwater sound. These responses include startle responses (C-turn) (e.g., Boeger et al. 2006; Hassel et al. 2004, 2003; McCauley et al. 2000a, b; Pearson et al. 1992) and alarm responses (e.g., tightening of schools, downward distributional shift, random movement and orientation) (Hassel et al. 2004, 2003; McCauley et al. 2000a, b; Pearson et al. 1992; Skalski et al. 1992). The papers referenced above used seismic airguns as the sound sources.

Numerous papers about the behavioural responses of fishes to marine vessel sound have been published in the primary literature. They consider the responses of small pelagic fishes (e.g., Sand et al. 2008; Ona et al. 2007; Jørgensen et al. 2004; Vabo et al. 2002; Misund et al. 1996), large pelagic fishes (Sarà et al. 2007), and groundfishes (e.g., De Robertis et al. 2008; Handegard et al. 2003; Engås et al. 1998). Generally, most of the papers indicate that fishes typically exhibit some level of reaction to the sound of approaching marine vessels, the degree of reaction being dependent on a variety of factors including the activity of the fish at the time of exposure (e.g., reproduction, feeding, and migration), characteristics of the vessel sound, and water depth.

As with marine invertebrates, effects on fish behaviour have also been studied using fishing efficiency as a measure. The most comprehensive experimentation on the effects of seismic airgun sound on catchability of fishes was conducted in the Barents Sea by Engås et al. (1996, 1993). They investigated the effects of seismic airgun sound on distributions, abundances, and catch rates of cod and haddock using acoustic mapping and experimental fishing with trawls and longlines. The maximum zero-to-peak source SPL was about 248 dB re 1 µPa at 1 m based on calculations using sound measurements collected by a hydrophone suspended at a depth of 80 m. No measurements of the received SPLs were made. Davis et al. (1998) estimated the received SPL at the sea bottom immediately below the array and at 18 km from the array to be 205 dB re 1 $\mu Pa_{0\text{-}p}$ and 178 dB re 1 $\mu Pa_{0\text{-}p}$, respectively. Engås et al. (1996, 1993) concluded that there were indications of distributional change during and immediately following the seismic airgun discharge (45% to 64% decrease in acoustic density according to sonar data). The lowest fish densities were observed within 9.3 km of the seismic discharge area. The authors indicated that trawl catches of both cod and haddock declined after the seismic operations. While longline catches of haddock also showed decline after seismic airgun discharge, those for cod increased.

Løkkeborg (1991), Løkkeborg and Soldal (1993), and Dalen and Knutsen (1986) also examined the effects of seismic airgun sound on demersal fish catches. Løkkeborg (1991) examined the effects on cod catches. The source SPL of the airgun array used in his study was 239 dB re 1 µPa at 1 m (unspecified measure type), but received SPLs were not measured. Approximately 43 hours of seismic airgun discharge occurred during an

11 day period, with a five-second interval between pulses. Catch rate decreases ranging from 55% to 80% within the seismic survey area were observed. This apparent effect persisted for at least 24 hours within about 10 km of the survey area. The effect of exposure to seismic sound on commercial demersal fishes was again studied in 2009 using gillnet and longline fishery methods off the coast of Norway (Løkkeborg et al. 2010). Study results indicated that fishes did react to airgun sound based on observed changes in catch rates during seismic shooting. Gillnet catches increased during the seismic shooting, likely a result of increased fish activity, while longline catches decreased overall.

In summary, the amount of documented information related to behavioural responses of marine fishes to underwater sound is greater than that for marine invertebrates. As with marine invertebrates, available information suggests that fish behavioural responses observed thus far are temporary but still a concern to fishers who believe that the reduced catchability still affects their fishing efficiency. There still remains uncertainty regarding the biological significance of fish behavioural response to underwater sound, but it is likely that exposure to sound can interrupt critical life history behaviours (e.g., reproduction).

Based on sound modelling of the cable installation activities in the Strait of Belle Isle and information from the literature, underwater sound produced during drilling and vessel transit will not likely evoke fish behavioural responses beyond 350 m from the source.

Based on sound modelling of the cable installation activities in the Strait of Belle Isle and information from the literature, underwater sound produced during vessels in dynamic positioning mode will not likely evoke fish behavioural responses beyond 1,325 m from the source.

The construction of the permeable berms at the electrode sites will be conducted from on-land. Noise, from the associated activities will evoke fish behavioural responses proximate to the construction activity but fish will likely habituate to the noise after a short time.

Change in Health of Macro-invertebrates and Fishes

Placement of rock during the construction of the Strait of Belle Isle and electrode site berms, and dredging at the Dowden's Point electrode site will likely affect the health of some macro-invertebrates and perhaps some fish as well. However, the numbers of macro-invertebrates and fish that will experience health effects represent a small proportion of all macro-invertebrates and fishes in the LSA.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project construction on the Fish KI are as follows:

- Adverse because of predicted behaviour and health effects due to rock berm placement and dredging;
- Low magnitude because the number of affected macro-invertebrates and fishes is expected to be within the range of natural variability;
- Limited to the RSA;
- Short-term duration because all behavioural and health effects at any particular location will persist for less than one year; and
- Low in frequency as the placements of rock berms and dredging will occur only once during the construction phase.

There is a moderate degree of confidence that the level of effect will not be greater than predicted because some of the likely residual effects on the fish are not as certain as those discussed for the other two KIs. While little uncertainty is associated with the residual effects on localized distributions and fish health, there is more uncertainty with likely residual effects on specific behaviours. However, the degree of confidence is supported by the rigor of the sediment modelling (AMEC 2011b), the collected baseline data related to the substrate characteristics (Sikumiut 2011a, b, c; AMEC 2011a, 2010; FJGI 2011, 2010), the sound modelling (Jasco 2011a, b), and available scientific literature. Uncertainties are addressed in the EIS through conservative estimates and assumptions, monitoring, and through adaptive management.

14.2.6 Operations and Maintenance

14.2.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

Activities and components of Project Operations and Maintenance that are most relevant to the Marine Fish and Fish Habitat VEC include operation of the submarine cables and shoreline electrodes, and major system repairs. Routine line inspections will also interact with this VEC but to a much lesser degree.

Mitigation that Nalcor will apply to Project activities during the Operations and Maintenance phase are as follow:

- screen / armouring of the cable is on the same electric potential as the outside ambient so that the electric field is confined to the inside of the cable;
- submarine cable armour and protective rock berm will minimize electric fields;
- the rock berm will serve as a partial barrier to the EMF generated by the cable;
- the cable will be laid on the seabed rather than buried which reduces the potential for a temperature increase to occur to the seabed and the associated biota;
- the rock breakwater berm at each electrode site will act as a barrier for invertebrates and fishes;
- routine visual inspections will be conducted with a remotely operated vehicle (ROV);
- electrodes will be designed to minimize electric and magnetic fields (e.g., through electrode design, electrode materials, electrode surface area, low resistivity surroundings);
- operation of electrodes under normal conditions as a bipole system will involve only low levels of electric current flowing through the electrodes (<1%);
- operation of electrodes under upset conditions as a monopole system will be minimized to the extent possible;
- minimization of contact area between the shoreline saltwater pond and the breakwater to ensure a safe voltage gradient on the sea side of the breakwater;
- system is expected to operate during monopolar operations (100%) for less than 40 hours per year; and
- biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

14.2.6.2 Existing Knowledge

Key references related to the effects of Operations and Maintenance activities of similar projects on marine fish and fish habitat are included in Table 14.2.6-1 and summary text on project context and study findings for each reference are also presented.

Table 14.2.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on the Marine Fish and Fish Habitat VEC

Reference	Study / Project Context	Summary of Findings
Electric Fields		
Poléo et al. 2001	– Literature study of the effects of HVdc sea cables and sea electrodes on marine life	– Concluded that weak electric fields from sea cables and sea electrodes have not adversely affected marine life
Nyman et al. 1988 *in* Tykeson et al. 1996	– Report on the calculation and measurements of the stray current effects of monopolar HVdc systems	– Unspecified fishes do not appear to react to electric field strengths of 2 volts per metre (V/m) or below
Fock et al. 1999 *in* Faugstad et al. 2007a	– Laboratory study of magnetic field barrier effects on baby eels	– No barrier effects were observed
Electromagnetic Fields		
Poléo et al. 2001	– Literature study of the effects of HVdc sea cables and sea electrodes on marine life	– Concluded that magnetic fields from sea cables and sea electrodes have not adversely affected marine life
Andrulewicz et al. 2003	– Study of environmental effects of the functioning SwePol Link HVdc submarine transmission cable in the Baltic Sea	– Changes in the components of the natural magnetic field were substantial in the vicinity of the cable but did not exceed natural variability at a distance of 20 m
Westerberg and Lagenfelt 2008	– Study of the effect of the magnetic fields generated by a sub-sea alternating current (ac) power cable on migrating European eel in the Baltic Sea	– Eel swimming speed was significantly lower around the vicinity of the power cable compared to further from the cable – No direct observational behavioural data to explain the lower swimming speed
Electrolysis Products		
Poléo et al. 2001	– Literature study of the effects of HVdc sea cables and sea electrodes on marine life	– Concluded that with particular electrode design and seawater exchange conditions, electrolysis products have not adversely affected marine life

14.2.6.3 Operations and Maintenance Effects: Benthic Habitat

The activities associated with the Operations and Maintenance of the submarine cables that are most likely to affect the Benthic Habitat KI include the following: (i) exposure of benthos to electric fields and EMFs generated by the submarine cable; and (ii) disruption of bottom habitat as a result of major system repairs. The various potential effects of these activities are discussed in this subsection. Other effects that could potentially occur include the heating of the sediment as a result of the dissipation of energy from operational cables, and accidental releases to the surficial sediment.

The activities associated with the Operations and Maintenance of the electrode sites that are most likely to affect the Benthic Habitat KI include the following: (i) exposure of benthos to electric fields and EMFs generated by the electrodes; (ii) exposure of surficial sediment and benthos to electrolysis product emissions from the electrodes; and (iii) direct loss of natural habitat as a result of dredging. The various potential effects of these activities are discussed in this subsection. Other effects that could potentially occur include the heating of the sediment as a result of the dissipation of energy from the electrodes, and accidental releases to the surficial sediment.

Introduction of Electric Fields

Background Information on Electric Fields

When current is injected into or collected by an electrode, a GPR occurs in the area surrounding the electrode. The magnitude of the GPR is dependent on the current and the resistivity of the surrounding medium. The GPR gradient is measured in volts, and it is the difference in voltage over a given distance that results in an electric field.

Electrode design, including design parameters such as the size of the shoreline saltwater pond, size of the breakwater, electrode element type, number and spacing of electrode elements, and low resistivity surroundings are all considerations in ensuring a safe GPR gradient on the sea side of the breakwater. CIGRE Working Group (1998) produced a guide for the design of electrodes associated with HVdc systems, and it has been accepted by the International Electrotechnical Commission as a Publicly Available Specification Pre-Standard (Altsom Grid 2010). The value of 1.25 V/m is presented as a safe design value (Alstom Grid 2010; CIGRE Working Group 1998; Electric Power Research Institute (EPRI) 1981; Kimbark 1971); and the GPR gradient on the sea side of both electrode sites for the Project will be designed to be less than 1.25 V/m.

Poléo et al. (2001) provides calculations for electric fields at and between electrodes (Table 14.2.6-2).

Table 14.2.6-2 Calculations of Electric Field Strengths Generated by Sea Electrodes[(a)]

Electrode Type	Current (A)	Distance from Electrode (m)	Field Strength (V/m)	Notes
Not specified	1,600	25,000	$<51 \times 10^{-6}$	Calculated by Telstad (1995)
Graphite (180 m^2)	1,500	0	2.5	Poléo et al. (2001)
Graphite (400 m^2)	1,500	0	1.1	Skagerrak link
Titanium (1,000 m^2)	1,500	0	0.45	Calculated by Poléo et al. (2001)
Titanium (375 m^2)	1,500	0	1.2	Calculated by Poléo et al. (2001)
Copper (296 m^2)	1,500	0	1.5	Calculated by Poléo et al. (2001)
Not specified	1,600	5	0.37	Calculated by Telstad (1995)

Source: Poléo et al. (2001).
(a) These calculations are based on sea electrodes which differ from the electrode design proposed for the Project. The field strength values are presented for comparison with the Hatch Ltd. (2011) values for the effects analysis.

The electric field produced by the submarine cable is different from the electrodes. The submarine cable design, including the shielding and the rock berm covering the cables, will result in no electric field around the submarine cables. There may be a weak electric field if there is any current leakage or stray current from various parts of the transmission system but these small potential sources are not considered here because of uncertainties in modelling such small variable sources and the fact that they are unlikely to produce effects.

Effects of Electric Fields on Invertebrates

While strong electric fields can affect all animals including invertebrates, there have been no reports of electric fields of the strengths expected for the Project adversely affecting marine benthic invertebrates (Poléo et al. 2001).

Effects of Project Electric Fields on Benthos

Based on the information presented in Table 14.2.6-2, the electric field strength generated at source by various electrode types range from 0.37 to 2.5 V/m. Hatch Ltd. (2011), citing un-named published literature, states that fish may be attracted to an anode at 5 V/m, tetanus could occur at 20 V/m, and mortality is possible at 50 V/m. Therefore, the anticipated electric field strengths associated with the Project (i.e., <1.25 V/m) are unlikely to adversely affect the benthos inhabiting the surficial sediments occurring close to the submarine cable and electrodes.

However, electricity flowing through a submarine cable will induce a magnetic field in the vicinity of the cable. These magnetic fields may have some potential to affect animal behaviour as discussed in subsequent sections.

Introduction of Electromagnetic Fields

Background Information on Electromagnetic Fields

As discussed in Section 14.2.4, the strength of the electromagnetic field (EMF) at various distances from the electrode has been modelled to aid in determining the zone of influence (ZOI) during both normal bipolar operations and upset conditions when the electrode is operating under monopolar operations (i.e., at 100%).

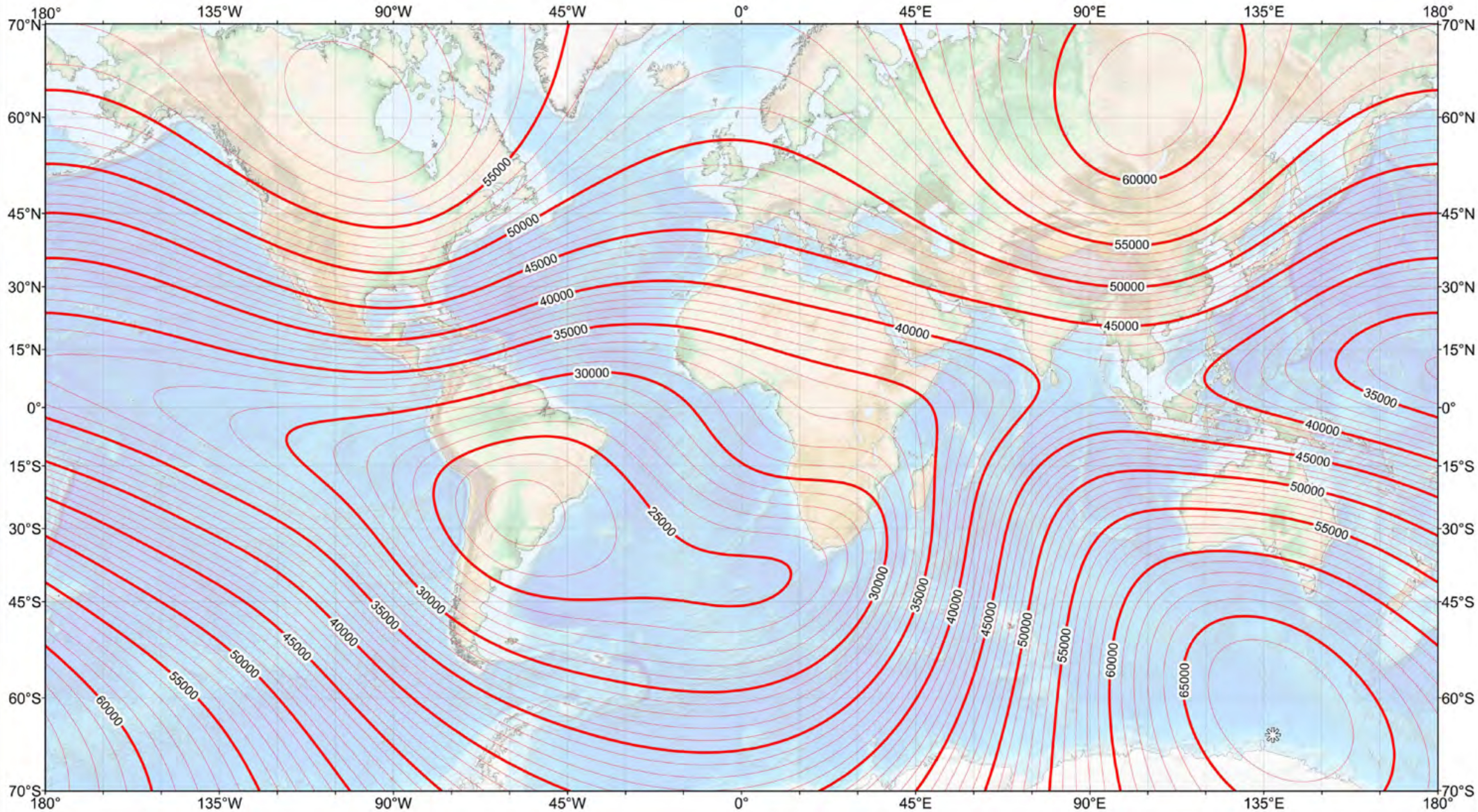
To predict the potential effects of electromagnetic emissions on marine fauna, it is first necessary to have a basic understanding of natural and anthropogenic sources. Secondly, information is required on how the various components of the ecosystem will respond to these emissions. Third, it is important to understand the nature and type of EMFs that the Project will generate.

Earth's Geomagnetic Field

The Earth generates a magnetic field with north - south polarity which forms the basis of the magnetic compass. This field is periodically disturbed by anomalies in the Earth's crust and by solar storms. Two principal features of the Earth's geomagnetic field are inclination and intensity. At any point on the Earth, magnetic field lines intersect the planet's surface at a specific angle (inclination) relative to the horizontal, ranging from 0 degrees (°) (parallel to the Earth) at the geomagnetic equator, to 90° at the geomagnetic poles. Because the geomagnetic field is roughly symmetrical around the Earth's surface, lines of equal inclination exist as equivalent rough lines of latitude around the geomagnetic axis (Wiltschko and Wiltschko 1995; Kirschvink et al. 1986).

The intensity of the geomagnetic field also varies. It is highest near the magnetic poles at 60,000 nano Tesla (nT), is about 40,000 to 50,000 nT at mid latitudes, and decreases to about 30,000 nT at the geomagnetic equator. The field value in the Strait of Belle Isle is in the order of 54,000 nT (Figure 14.2.6-1).

Superimposed on this global magnetic field are local magnetic deviations, distortions, and anomalies that vary irregularly over the Earth's surface. This geomagnetic topography consists of magnetic hills and valleys of varying size and intensity that are associated with the magnetic nature of underlying rock and localized dynamics in the Earth's iron core. High concentrations of magnetized rock localized in areas of low magnetic concentration create strong magnetic gradients. Regional gradients typically are subtle. In north-eastern North America, field intensity changes at about 3.4 nT/km, whereas the regional gradient across central Europe is 2.5 nT/km (Wiltschko and Wiltschko 1995; Kirschvink et al. 1986).



Main Field Total Intensity (F)
Contour interval: 1000 nT.
Mercator Projection.
: Position of dip poles

Map developed by NOAA/NGDC & CIRES
http://ngdc.noaa.gov/geomag/WMM/
Map reviewed by NGA/BGS
Published January 2010
Source: (Anonymous, n.d., internet site)

FIGURE 14.2.6-1

Earth's Magnetic Field (Total Intensity; nT)

The Earth's magnetic field is also subject to short- and long-term variations. Solar electromagnetic radiation impinging on the Earth's surface can cause daily fluctuations in field intensity of up to 30 nT and shifts in inclination of up to 0.33°. These daily perturbations vary with latitude and season. Magnetic storms associated with sun spot activity also cause fluctuations of 200 nT or more. The geomagnetic field also undergoes long-term drift with field intensity varying about 0.05% per year with periods of several thousand years. There is also a westward drift in the field of about 0.2° longitude per year (Wiltschko and Wiltschko 1995; Kirschvink et al. 1986). In addition, there are many anthropogenic sources of electromagnetic fields in the marine environment such as transmission lines, fibre optic cables, pumps and pipelines, and marine survey equipment.

The above notwithstanding, Earth's geomagnetic field potentially provides a reliable global positioning system for any organism that can detect and interpret the magnetic landscape in terms of relative position and / or directional orientation.

A large variety of organisms have been shown to respond to geomagnetic cues: magnetotactic bacteria (Kirschvink 1980), protists (Bazylinski et al. 2000), gastropods (Lohmann and Willows 1987), crustaceans (Lohmann et al. 1995), insects (Riveros and Srygley 2010), bony fish (Walker 1984), amphibians (Diego-Rasilla et al. 2010), Sea Turtles (Goff et al. 1995), birds (Wiltschlko et al. 2010), and migratory whales (Kirschvink et al. 1986).

Induction

The flow of dc current through cables and conductors, as well as through the sea and soil, creates a magnetic field. The magnitude of the magnetic field at a point depends on the location relative to the current carrying conductor / body, the magnitude of the current and the relative permeability of the medium at the location. The concept of electrical induction is a key element for understanding the pathway by which electrical transmissions may disrupt nearby marine life. As defined by Faraday's Law, an electrical current is generated, or "induced", in any conductor moving through a magnetic field. Magnetic fields have polarity (north and south poles) and the direction of current flow within a conductor is a function of the direction in which the conductor moves relative to the north - south orientation of the magnetic field. If a conductor moves from left to right relative to the north - south orientation, current will flow in one direction, and if it moves from the right to the left current will flow in the opposite direction. If a conductor is moved back and forth within the magnetic field, the current will alternately flow in opposite directions; an alternating current is generated. A current may also be induced in a stationary conductor if the surrounding magnetic field is in motion. Either way, electrical induction depends upon movement. Either a conductor must move within a magnetic field, or a magnetic field must move past a stationary conductor. If both elements are motionless, no electric current is induced.

Just as a magnetic field induces an electric current in a conductor, an electric current creates a magnetic field in the space surrounding the conductor. When current flow is initiated a magnetic field expands around the conductor. When current flow eventually stabilizes, the surrounding magnetic field stops expanding and becomes a static magnetic field. If the current is shut off, the magnetic field collapses. The polarity of the magnetic field depends upon the direction of current flow. When current flow reverses in a conductor, the polarity of the surrounding magnetic field reverses. When an ac current is applied, the surrounding magnetic field continually expands and collapses at the frequency of the current.

The relevance of electrical induction to the underwater transmission of electricity is that all animals are electrical conductors. Biological organisms continually generate internal voltage gradients and electrical currents including those associated with the nervous system, all types of biochemical reactions ranging from digestion to higher brain functions, sensory and motor mechanisms, reproductive processes, and membrane integrity. EMFs of sufficient strength have the ability to induce micro-currents within an organism and possibly disrupt these normal electrical functions. Induction of micro-currents could be associated with either the electrical or magnetic component of the electromagnetic wave.

Again it is important to note that the Project current will be direct current (dc) and the electrical component of the EMF has a frequency of 0 Hz. This is non-ionizing radiation as compared to ionizing radiation of X-rays and gamma rays (very high frequencies up to 10^{16} Hz). As such, dc and low frequency ac (e.g., 60 Hz of North American household current) have little if any potential to cause health effects on animals (Canadian Electrical Association 2010; Health Canada 2010; World Health Organization (WHO) 2007). It also should be noted that some of the reported subtle effects of electric fields on marine organisms originate from laboratory experiments conducted using ac current.

Geomagnetic Navigation

It has been theorized by many scientists that the planet's geomagnetic field is the primary template that many forms of life use as a navigation coordinate system. It is the dominant feature that underlies the theory of geomagnetic navigation in animals. As such, any disruption to this field could have adverse effects on marine fauna.

"True navigation" relies on a bi-coordinate positioning system. For an animal to determine its location using magnetic parameters alone, it must: (i) be able to perceive at least two distinct parameters of the Earth's geomagnetic field, and (ii) these parameters must vary relative to each other across the Earth's surface such that a grid is formed from which a position can be fixed. For animals that migrate long distances, such a system would provide both directional and positional information. However, for animals to navigate using this type of system, they must be able to detect small gradients in the magnetic field on the order of 5 to 10 nT/km and an inclination of about 0.01°/km. They would have to do this while simultaneously compensating for daily changes in magnetic conditions from local anomalies or solar events on the order of 30 to 200 nT and in inclination of about 0.33° (Wiltschko and Wiltschko 1995; Kirschvink et al. 1986). In addition, geomagnetic drift over an individual's life time could cause errors in position determination.

The two dominant categories of theories for geomagnetic navigation in animals involve: (i) magnetoreception models (see Wiltschko and Wiltschko 1995) using magnetite (found in many animals) and some cellular level intermediary such as bacteria, and (ii) the radical pairs models (Ritz et al. 2000; Schulten and Windemuth 1986) which suggest the use of specialized chemical processes to transfer magnetic information.

Even though the idea of geomagnetic navigation is a major field of scientific study, the mechanisms by which animals could implement a bi-coordinate mapping system and overcome its many challenges remain unknown. Adding to the complexity is the role that other environmental cues such as olfaction, celestial navigation, visual landmarks, currents, and temperature / salinity gradients may play, either interactively with geomagnetic navigation or at times dominating the navigation process.

Effects of Electromagnetic Fields on Invertebrates

Magnetic fields of 1 to 100 microTesla (µT) (1,000 to 100,000 nT) have been reported to delay embryo development in sea urchins (Cameron et al. 1993, 1985; Zimmerman et al. 1990). In contrast, Bochert and Zettler 2004 (cited in Gill et al. 2005) reported no significant adverse effects on brown shrimp (*Crangon crangon*), round crab (*Rhithropanopeus harrisii*), isopod (*Saduria entomon*), bivalve mollusc (*Mytilus edulis*) and flounder (*Plathicthys flesus*) from exposure to static magnetic fields. As noted previously, a wide variety of marine invertebrates orient to geomagnetic cues including magnetotactic bacteria, protists, gastropods, and crustaceans. A magnetic compass sense has been reported for spiny lobster (*Panulirus argus*) (Lohmann et al. 1995). Other marine invertebrates known to possess magnetic compass sense as reviewed in Meisner and Sordyl (2006) are the amphipod crustaceans *Talitrus saltator, Orchestia cavimana*, *Talorchestia martensii*, and the isopod *Idotea baltica* and the nudibranch gastropod *Tritonia diomedea.* Attraction of brown shrimp to magnetic fields generated by offshore wind farms has been reported by International Conference on Evolvable Systems (ICES) (2003) (cited in Gill et al. 2005).

Based on the results of the literature review conducted for this assessment, adverse effects have not been demonstrated on marine benthic invertebrates from the electric or magnetic fields produced by HVdc cables and associated shore electrodes. Multi-year monitoring studies (reviewed in Faugstad et al. 2007b, internet site) in the Baltic Sea where there are a number of HVdc cables, have failed to show any measurable negative effects on sediments or blue mussels, and benthic recolonization around electrodes (Norway Skagerrak and two Baltic cables) appeared to be normal. At the Konti-skan electrode starfish and crab have been observed living on electrodes and fish have been observed near them even at a 6 V/m electric field (Faugstad et al. 2007b, internet site). Meisner and Sordyl (2006) in a major review of the effects of underwater transmission cables concluded:

> *"In summary, information available is not sufficient to make reasonable statements on possible effects of electromagnetic fields on benthic organisms. However, in regard to benthic marine invertebrates, such effects may only occur in close vicinity to the cables."*

Effects of Project Electromagnetic Fields on Benthos

The Project will have two main sources of EMFs in the marine environment: (i) three submarine HVdc cables; and (ii) the two shoreline electrodes (L'Anse au Diable in the Strait of Belle Isle and Dowden's Point in Conception Bay).

Again it is important to note that the Project current will be direct current (dc) and the electrical component of the EMF has a frequency of 0 Hz. This is non-ionizing radiation as compared to ionizing radiation of X-rays and gamma rays (very high frequencies up to 10^{16} Hz). As such, dc and low frequency ac (e.g., 60 Hz of North American household current) have little if any potential to cause health effects on animals (Canadian Electrical Association 2010; Health Canada 2010; World Health Organization (WHO) 2007). It also should be noted that some of the reported subtle effects of electric fields on marine organisms originate from laboratory experiments conducted using ac current.

The shielded and buried cables will not generate an external electric field. However, a static magnetic field will be generated around the cables and a weak electrical current (induced current) will be generated by any conductor moving through this field (e.g., fish) (Faraday's Law). There also may be a weak electric field if there is any current leakage or stray current from various parts of the transmission system but these small potential sources are not considered here because of uncertainties in modelling such small variable sources and the fact that they are unlikely to produce measurable effects. The specific size of the field will depend on local conditions but would be in the order of 150 m as calculated by the Biot-Savart Formula (Worzyk 2009). The magnetic field strength attenuates rapidly from 260 µT (260,000 nT) at 1 m from the cable to 26 µT (26,000 nT) at 10 m as calculated using the Biot-Savart Formula using a maximum current of 1,286 amperes (A).

The transmission system will be operated in the bipolar mode during normal operational conditions and thus relatively small EMFs will be produced at the electrodes. During monopolar operations (i.e., 100% of the current flowing through the electrode), larger EMFs will be produced. The electric field will be <1.25 V/m in the seawater on the sea side of the berm; see Tables 3-3 and 3-4 in Hatch Ltd. 2011). If levels reached 5 V/m, they could attract some species and sizes of fish in the immediate vicinity, but this level is believed to be not harmful to fish (Hatch Ltd. 2011) and should not be encountered on the seaward side of the berm given the proposed electrode design.

A potential ZOI of the electrodes on marine fauna can be estimated using the modelling of the magnetic flux density (Hatch Ltd. 2011) and potential sensitivities of some marine animals as reported in the literature. To provide a conservative ZOI, a water depth of 0 m and the higher amperage 320 kV HVdc system were chosen as the parameters. There would be two ZOIs: (i) from a continuous and normal bipole system operation imbalance current at 14.06 A, and (ii) from the fault condition of monopole operation with a fault current of 2,109 A (predicted to occur sporadically for a maximum total of 40 hours (hrs) per year).

To be conservative, the 0 m water depth was chosen for this assessment because the induced magnetic field intensity at the surface is higher than at any other point in the water because of partial cancellation of flux at the top layer of water. The induced flux intensities will be zero at a point where currents in the water above and below the point are equal. The flux intensity at the bottom of the sea will be less than at the surface and in the opposite direction (about the z-axis). The change of sea surface elevation with the tide will result in lower magnetic field intensities since current magnitudes will remain the same but the observation will be farther from the water layers.

The 320 kV modelling scenario was selected from Hatch Ltd. (2011) because this system would operate at a higher amperage than the proposed Project, a 350 kV system. This represents a conservative approach as the 320 kV model produces greater electric and electromagnetic fields than the proposed Project.

A threshold of effects on marine fauna at a magnetic flux density of 200 nT (2 x 10^{-7} T) is a reasonable (and conservative) value to use to define the ZOI of the electrodes. Referring to Hatch Ltd. (2011), a surface ZOI for normal operations can be defined at some distance from the electrodes of equal to or less than 50 to 100 m (see Hatch Ltd. 2011, Tables 3-15 and 3-19, B_{res} values reported as natural Earth values plus those induced by the Project).

The upset condition where the system is operating in monopolar operation (i.e., maximum continuous current) results in a ZOI radius for the electrodes on the order of 500 m for L'Anse au Diable and Dowden's Point (see Hatch Ltd. 2011, Table 3-13 and 3-17, B_{res} values).

It should be noted that the 200 nT threshold was chosen as a conservative level where a diversity of marine animals (both invertebrates and vertebrates) may be able to detect and react (e.g., Kirschvink 1990; Semm and Beason 1990; Kirschvink et al. 1986; Walker and Bitterman 1989). Several species have been exposed to levels many times above this level with no reactions and no ill effects. Not all individuals or species will always react; and not all reactions will necessarily be negative. Delay or alterations in migratory patterns would be a potential negative effect but animals in the natural environment regularly encounter anomalies. For example, there are at least 27 geomagnetic events per year of 200 nT or more (National Oceanic and Atmospheric Administration (NOAA) 2011, internet site).

Introduction of Electrolysis Products

Background Information on Electrode Electrolysis Products

When HVdc links operate, especially in the monopole mode, the return current through the seawater consists of ions that move in the direction of the electrodes. These ions, water molecules and dissolved oxygen react electrochemically with the electrodes, resulting in the formation of various electrolysis products. At the cathode, the negatively charged electrode, water molecules and oxygen in the seawater are reduced (i.e., gain electrons), while at the anode, the positively charged electrode, negatively charged ions and water molecules are oxidized.

A number of toxic primary and secondary electrolysis products are formed at the electrode anode including chlorine, hypochlorite, hypobromite, chloroform, bromoform and other halogenated organic compounds (Poléo et al. 2001). As the relative toxicities of these compounds vary considerably among species, the most reasonable way of evaluating the toxic effects of the electrolysis products is to consider the concentration of residual chlorine, the amount of chlorine that remains dissolved in the seawater (Poléo et al. 2001). A residual chlorine concentration of 0.35 to 0.55 milligrams per litre (mg/L) is reported to have a lethal effect on phytoplankton (Hall et al. 1982). The lowest residual chlorine concentration reported to have sub-lethal effects on algae is 0.01 mg/L (Hall et al. 1982; Eppley et al. 1976). The lowest concentration of residual chlorine reported to have toxic effects on aquatic invertebrates and fishes is also 0.01 mg/L (Rhoderick et al. 1977). Fish avoidance responses have been reported for residual chlorine concentrations of 0.002 mg/L (Hall et al. 1982) and 0.001 mg/L (Brungs 1973).

The amount of chlorine produced per unit time per ampere varies with electrode surface material and surface area. Tidal flushing at both electrode sites will continuously reduce the emission concentrations in the saltwater ponds. The expected chlorine concentrations from a day of monopolar (maxiumum continuous current) electrode operation at the shoreline electrode ponds at L'Anse au Diable and Dowden's Point is 0.689 mg/L and 0.897 mg/L, respectively (Hatch Ltd. 2011). Note that these values do not consider gas exchange with the air or exchange with the seawater due to concentration differential so expected maximum chlorine concentrations would realistically be lower. As noted previously, this upset condition of the system is only expected to occur sporadically for less than 40 hours per year. The electrode selected will have a large surface area and will be designed to allow for an appropriate seawater exchange; therefore, no harmful effects of exposure to toxic electrolysis products on marine organisms are likely.

Effects of Project Electrode Electrolysis Products on Surficial Sediment and Benthos

Poléo et al. (2001) presented results of some studies related to the effects of HVdc links electrolysis products on marine fish and fish habitat. Keussen (1994) reported on observable effects of electrolysis products on flora occurring near the electrode station of the German Fenno-Skan HVdc link. The report is not conclusive about the effects of electrode residual chlorine on the algae.

Direct observation has suggested a lack of electrode avoidance responses by invertebrates and fishes (Nielsen 1986). Sandström (1996) reported no measurable differences in fish catches between an electrode station and two reference stations. Karoliussen and Tunold (1998) concluded that crabs occurring near graphite electrodes had bleached carapaces, likely due to exposure to chlorine produced during electrode electrolysis. However, this observed colouration could be within this crab species' spectrum of natural colour variation.

A recent study associated with the Skagerrak HVdc link between Denmark and Norway found the accumulation of 12 organic halogen compounds in the sediment proximate to the electrodes (Berge et al. 2000). Another study conducted in Denmark (Lyngby and Ahrensberg 1998) observed increased concentrations of halogen compounds in sediment and blue mussels (*Mytilus edulis*) occurring in the electrode area. Note that neither of these two studies provided any reliable data on actual production of electrolysis products during electrode operation.

Hatch Ltd. (2011) calculated emissions and concentrations of H_2 and Cl_2 in the saltwater pond water of the electrodes assuming 100% hydrogen selectivity and 30% chlorine selectivity, at two voltages, 320 kV and 400 kV as 'book ends' scenarios for the operating parameters for the Project as the system voltage had not yet been finalized. The emissions calculated for 320 kV were greater, and are therefore presented here as a conservative approach.

Table 14.2.6-3 and Table 14.2.6-4 provide the relevant calculations for the L'Anse au Diable electrode, and the two scenarios for the Dowden's Point electrode during normal bipolar operations and maximum continuous monopolar operations, respectively. Estimated concentration of Cl_2 as a result of tidal flushing are also presented in Table 14.2.6-3 and Table 14.2.6-4.

Based on the numbers in Table 14.2.6-3, the maximum amount of Cl_2 that would be produced at each electrode site during normal bipolar operations is 134 g per day. With consideration of tidal flushing, the estimated concentration during maximum continuous monopolar operations, is estimated to be 20,000 g of Cl_2 produced each day at one of the electrode sites (Table 14.2.6-4). The theoretical information that these two tables do not provide is how the Cl_2 concentration varies with distance from the anode, particularly on the seaward side of the berm. However, both electrode sites occur in relatively high water energy environments so Cl_2 concentrations on the seaward sides of the berms are expected to remain very low due to the dilution effect of the seawater.

The amount of H_2 being produced at the cathodes is not an issue. In fact, none of the electrolysis products formed at the cathode are known to be toxic to marine life (Poléo et al. 2001).

Table 14.2.6-3 Cl_2 and H_2 Yields for the Proposed Electrode Sites during Normal Bipolar Operations

Variable	Units	L'Anse au Diable	Dowden's Point-Extended Berm	Dowden's Point-Shoreline Berm
Cl_2 [(a)]	kg/s	1.55×10^{-6}	1.55×10^{-6}	1.55×10^{-6}
Cl_2 [(a)]	kg/year	4.89×10^{1}	4.89×10^{1}	4.89×10^{1}
H_2 [(a)]	kg/s	5.89×10^{-7}	5.89×10^{-7}	5.89×10^{-7}
H_2 [(a)]	kg/year	1.86×10^{1}	1.86×10^{1}	1.86×10^{1}
Saltwater pond volume	L	2.92×10^{7}	2.24×10^{7}	$2.70\ 10^{6}$
$[Cl_2]$ / day[(a)]	g/L	4.59×10^{-6}	5.98×10^{-6}	4.96×10^{-5}
$[H_2]$ / day[(a)]	g/L	1.74×10^{-6}	2.27×10^{-6}	1.88×10^{-5}
Estimated $[Cl_2]$/ day with tidal fluhing	g/L	2.10×10^{-6}	1.83×10^{-6}	1.80×10^{-5}

(a) Calculated values are 0.01 x normal monopolar operations numbers.

Table 14.2.6-4 Cl_2 and H_2 Yields for the Proposed Electrode Sites during Maximum Continuous Monopolar Operations

Variable	Units	L'Anse au Diable	Dowden's Point-Extended Berm	Dowden's Point-Shoreline Berm
Cl_2	kg/s	2.32×10^{-4}	2.32×10^{-4}	2.32×10^{-4}
Cl_2	kg/year	7.33×10^{3}	7.33×10^{3}	7.33×10^{3}
H_2	kg/s	8.83×10^{-5}	8.83×10^{-5}	8.83×10^{-5}
H_2	kg/year	2.78×10^{3}	2.78×10^{3}	2.78×10^{3}
Saltwater pond volume	L	2.92×10^{7}	2.24×10^{7}	$2.70\ 10^{6}$
$[Cl_2]$/ day	g/L	6.89×10^{-4}	8.97×10^{-4}	7.44×10^{-3}
$[H_2]$ / day	g/L	2.62×10^{-4}	3.37×10^{-4}	2.80×10^{-3}
Estimated $[Cl_2]$/ day with tidal fluhing	g/L	3.15×10^{-4}	2.75×10^{-4}	2.70×10^{-3}

Source: Hatch Ltd. (2011).

It is important to note that chlorine selectivity will likely be considerably less than 30%, and that factors not considered in the development of the above numbers include gas evaporation from the saltwater pond, chlorine movement into the sea through the permeable zone due to concentration differential, and chlorine reaction with water. Also the saltwater pond volumes stated above are likely underestimations, thereby lowering the Cl_2 and H_2 concentrations considerably. Products of the primary anode and cathode reactions will react with water and minerals in the water in unpredictable, complex ways. As already indicated, none of the electrolysis products at the cathode are known to be toxic to marine life. While the electrolysis products at the anode (i.e., chlorine and secondary electrolysis products) can be toxic to marine flora, invertebrates and fishes at certain concentrations, they are unlikely to be this concentrated at the L'Anse au Diable and Dowden's Point electrodes given the predicted modelling results, and the tidal flushing and high water energy at both electrode site locations.

Based on the related literature, there seems to be some possibility of accumulation of certain organic halogen compounds in the surficial sediment occurring proximate to the Project electrodes. However, it is important to note that contaminants in marine sediments are commonly related to particle size and organic carbon content (Halcrow et al. 1973). Referring to Sikumiut (2011a), the substrate classification and carbon content in the vicinity of the electrode sites would not be considered optimal as there was an absence of a clay sediment fraction. The benthos inhabiting this sediment could potentially be affected as well although the level of effect is not known. Despite the chance of effect of the electrolysis products on surficial sediment and benthos, the ZOI is likely to be small.

Direct Loss of Natural Habitat

There is potential of direct loss of natural habitat during the Operations and Maintenance of the submarine cables and electrode sites, specifically due to major repairs associated with the submarine cable and any dredging required at the electrode sites to maintain the required water depth in the vicinity of the electrodes. It is not possible to quantify the potential loss of habitat during this phase of the Project but it would be substantially less than the amount of natural habitat lost during the construction, and would occur in previously disturbed areas. The direct loss of natural habitat, and the associated change in health of benthos, change in bottom substrate class and change in benthic community structure during the Operations and Maintenance of the submarine cables and electrode sites will be small relative to the entire LSA.

Heating of the Surficial Sediment

Submarine cable and electrode heat dissipation modelling indicated a minimal increase in saltwater pond water temperature (i.e., <0.5°C) (Hatch Ltd. 2011). Given that the electrodes will be at least 1 m from the bottom sediment, it is likely that any sediment temperature increase as a result of heat dissipation from the submarine cables and electrodes will be negligible.

Accidental Releases

Unintentional releases of small amounts of potentially deleterious substances (e.g., hydrocarbons) to the marine environment during Project Operations and Maintenance activities could result in localized changes to surficial sediment chemistry which in turn could potentially cause adverse effects on the health of biota coming into contact with the affected sediment. Again, with consideration of the mitigations proposed by Nalcor, the spatial scale of such an effect would be small.

Assessment of Operations and Maintenance Effects on Benthic Habitat

The primary likely effect of the operation of the submarine cables on Benthic Habitat relates to disturbance to benthic faunal behaviour. The cables will produce EMFs which might be detectable by certain biota. The operation of the shoreline electrodes has the potential to cause more effects than the submarine cable. In addition to emitting electric fields and EMFs, electrolysis at the operating electrode site anode may affect the chemistry of bottom sediment close to the seaward side of the permeable berm.

While routine inspection and maintenance of the marine components of the transmission system might temporarily disturb benthic fauna (e.g., ROV passing along the berms), major system repairs would have substantially greater effect on the Benthic Habitat. Major repair of the submarine cable would require removing the berm from two times the water depth and bringing a portion of the cable to the surface. Disruption of the rock berm could result in direct loss of natural bottom habitat, direct mortality of benthic biota, a change in bottom substrate class, and a change in benthic community structure. Surficial sediment chemistry could also be altered in the event of an accidental release of deleterious substances to the marine environment.

The activity associated with major repair work at the electrode sites that would have greatest effect on the Benthic Habitat is dredging. A minimum water depth is required in the electrode saltwater ponds and if sedimentation occurs over time, dredging will be required, and may occur at the Dowden's Point electrode site, however it is not expected at the L'Anse au Diable electrode site. Potential effects of dredging on Benthic Habitat are the same as those described for major repair work on the Strait of Belle Isle submarine cable.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on the Benthic Habitat KI are as follows:

- Adverse, primarily because of the emissions from the cable and electrodes, and the disruption of the bottom habitat and associated biota as a result of major repair work;
- Low magnitude because the amount of affected Benthic Habitat is expected to represent a small proportion of similar Benthic Habitat in the area;
- Limited to the LSA;
- Far future duration because cable and electrode emissions will occur throughout the Operations phase; and
- Continuous in frequency as inspection and maintenance will occur and EMFs will be generated throughout the Operations and Maintenance phase.

There is a moderate degree of confidence that the level of effect will not be greater than predicted because, despite the electric fields, EMF and electrolysis products modelling, there remains uncertainty about the effects of these emissions on biota. The existing relevant literature suggests that effects on the Benthic Habitat KI are minimal. There is much more certainty about the effects of major repairs on the submarine cable and dredging at the electrode sites but the occurrences of both of these activities are less definite than the submarine cable and electrode emissions. Uncertainties are addressed in the EIS through conservative estimates and assumptions, monitoring and through adaptive management.

14.2.6.4 Operations and Maintenance Effects: Marine Water Quality

Effects that could potentially occur as a result of Operations and Maintenance of the submarine cables include heating of the seawater proximate to the cables, re-suspension of bottom sediments (i.e., increase in turbidity) in the event of major system repairs, introduction of anthropogenic underwater sound to the marine environment in the event of major system repairs and changes to seawater chemistry as a result of accidental release of small amounts of potentially deleterious substances to the marine environment.

The activities associated with the Operations and Maintenance of the electrode sites that are most likely to affect the Marine Water Quality KI include the following: (i) exposure of seawater and plankton to electrolysis product emissions from the electrodes; and (ii) exposure of plankton to electric fields and EMFs generated by the electrodes. The various potential effects of these activities are discussed in this subsection. Other effects that could potentially occur include heating of the seawater proximate to the electrodes, re-suspension of bottom sediments (i.e., increase in turbidity) in the event of dredging, introduction of anthropogenic underwater sound to the marine environment in the event of dredging, and changes to seawater chemistry as a result of accidental release of small amounts of potentially deleterious substances to the marine environment.

Introduction of Electrolysis Products to Seawater

General background information related to the introduction of electrolysis products from electrodes is provided in the previous subsection Operations and Maintenance Effects: Benthic Habitat.

Based on the related literature, electrolysis products such as Cl_2 and H_2 will be produced in the seawater but quickly undergo secondary and tertiary chemical reactions. Phytoplankton and zooplankton occurring close to the electrodes could potentially be affected but the ZOI is likely to be small.

Introduction of Electric Fields Products to Seawater

General background information related to the introduction of electric fields from both submarine cables and electrodes is provided in the previous subsection Operations and Maintenance Effects: Benthic Habitat.

Based on the related literature, electric fields will be generated into the seawater, and phytoplankton and zooplankton occurring close to the cables and electrodes could potentially be affected. However, any effect is expected to be minimal and the ZOI is likely to be small.

Introduction of Electromagnetic Fields to Seawater

General background information related to the introduction of EMFs from both submarine cables and electrodes is provided in the previous subsection Operations and Maintenance Effects: Benthic Habitat.

Based on the related literature, EMFs will be generated and will attenuate into the seawater, and phytoplankton and zooplankton occurring close to the cables and electrodes could potentially be affected. However, any effect is expected to be minimal and the ZOI is likely to be small.

Heating of Seawater

Heat dissipated by the submarine cables and the electrodes was modelled (Hatch Ltd. 2011). Included in this report are estimations of maximum temperature rise in the electrode saltwater ponds under monopolar conditions. Temperature rise of the water in the electrode saltwater ponds is not expected to exceed 0.5°C.

Re-suspension of Bottom Sediments

Background information on increased turbidity in seawater is provided in the subsection Construction Effects: Marine Water Quality. Any major repairs of the submarine cables or required dredging at the electrode sites will result in some re-suspension of bottom sediment and, therefore, an increase in turbidity. However, given the coarse nature of the bottom sediments within the submarine cable crossing corridor and the electrode sites, re-suspension would likely be minimal.

Introduction of Underwater Sound

Background information on underwater sound detection and observed behavioural effects of exposure to underwater sound on marine invertebrates is provided in the subsection Construction Effects: Marine Water Quality. Any major repairs of the submarine cables or required dredging at the electrode sites will result in the introduction of additional underwater sound to the marine environment, although much less than what will be introduced during Project construction. Zooplankton exposed to the additional sound might exhibit behavioural responses that result in a slight shift in localized distribution but it would be small.

Accidental Releases

Unintentional releases of small amounts of potentially deleterious substances (e.g., hydrocarbons) to the marine environment during Project Operations and Maintenance activities could result in localized changes to seawater chemistry which in turn could potentially cause adverse effects on the health of biota coming into contact with the affected seawater. Again, the spatial scale of such an effect would be small given the size of the release being considered, and the mitigations proposed by Nalcor.

Assessment of Operations and Maintenance Effects on Marine Water Quality

The likely potential effect of the operation of the submarine cables on Marine Water Quality is emission of EMFs into the seawater. The operation of the shoreline electrodes will not only result in the emission of an EMF into the seawater, but also the introduction of chemicals resulting from electrolysis at the anode (e.g., chlorine).

While routine inspection and maintenance of the marine components of the transmission system will not likely affect Marine Water Quality, major system repairs could have an effect on the Marine Water Quality. Major repair of a submarine cable would likely require removing the berm from two times the water depth and bringing a portion of the cable to the surface. Disruption of a rock berm could result in increased turbidity in the lower water column. Noise created during major repairs could temporarily alter the local distribution of zooplankton. Seawater chemistry could also be altered in the event of an accidental release of deleterious substances to the marine environment, which in turn could have effects on plankton health.

As is the case with Benthic Habitat, the activity associated with major repair work at the electrode sites that would have greatest effect on the Marine Water Quality is dredging. A minimum water depth is required in the electrode saltwater ponds and if sedimentation occurs over time, dredging will be required. Potential effects of dredging on Marine Water Quality are the same as those described for major repair work on the Strait of Belle Isle submarine cable.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on the Marine Water Quality KI are as follows:

- Adverse, primarily because of the emissions and the increased turbidity during dredging of the electrode sites;
- Low magnitude because the volume of seawater affected by EMFs and electrolysis emissions, and increased turbidity is expected to represent a small proportion of seawater in the area;
- Limited to the LSA or just into the RSA;
- Far future duration because cable and electrode emissions will occur throughout the Operations and Maintenance phase; and
- Continuous in frequency as inspection and maintenance will occur and electrolysis emissions and EMFs will be generated throughout the Operation and Maintenance phase.

There is a moderate degree of confidence that the level of effect will not be greater than predicted because, despite the electric field, EMF and electrolysis products modelling, there remains uncertainty about the effects of these emissions on a variety of biota species. The existing relevant literature suggests that effects on the Marine Water Quality KI are minimal. There is much more certainty about the effects of major repairs on the submarine cable and dredging at the electrode sites on this KI but the occurrences of both of these activities are less definite than the submarine cable and electrode emissions. Uncertainties are addressed in the EIS through conservative estimates and assumptions, monitoring and through adaptive management.

14.2.6.5 Operations and Maintenance Effects: Fish

Activities associated with the Operations and Maintenance of the submarine cables and the electrode sites that are most likely to affect the Fish KI are as follow: (i) the introduction of electrolysis products to the marine environment at the electrodes; and (ii) the introduction of electric fields and EMFs to the marine environment at the submarine cable and electrodes. The primary potential effects of these activities on macro-invertebrates and fishes are changes in behaviour and changes in health. Other potential effects and associated Operations and Maintenance activities include behavioural changes in macro-invertebrates and fishes as a result of the introduction of additional underwater sound to the marine environment as a result of major system repair and / or dredging, sub-lethal and lethal physical effects on some macro-invertebrates and fishes as a result of dredging and heat dissipation at the electrode sites, and changes in the health of macro-invertebrates and fishes as a result of accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons).

Change in Macro-invertebrate and Fish Distribution, Feeding Behaviour and Reproductive Behaviour

Effects such as distributional shifts, changes to feeding behaviour and changes to reproductive behaviour could potentially result from the exposure of macro-invertebrates and fishes to Project Operations and Maintenance activities that include electric field emissions from both submarine cables and electrodes, EMF emissions from both submarine cables and electrodes, electrolysis product emissions from the electrodes and the introduction of additional underwater sound to the marine environment during major cable repair and dredging at the electrode sites.

Background information pertaining to electric fields, EMFs, electrolysis product emission and underwater sound is presented in previous subsections. The following text discusses the current knowledge of the effects of electric fields and electromagnetic fields on fishes. Similar information related to marine invertebrates was presented in the subsection Operations and Maintenance: Benthic habitat.

Effects of Electric Fields on Fishes

Effects of electric fields on fish have been reviewed in Poléo et al. (2001). Thresholds of effects vary greatly between elasmobranchs and teleosts. Thresholds for behavioural effects on elasmobranchs have been reported as low as 0.5 microvolts/metre (µV/m) (e.g., prey detection). Teleosts have been reported to detect electric fields as low as 7,000 µV/m and to have reactions at fields as low as 0.5 V/m (Poléo et al. 2001).

Effects of Electromagnetic Fields on Fishes

The following discusses the literature pertaining to the effects of EMFs on marine fishes.

There is no evidence to suggest that EMFs emitted by submarine HVdc cables or associated electrodes adversely affect marine fish to any great extent. Nonetheless, there is some potential for fish to be affected at both the physiological and behavioural levels (Öhman et al. 2007; WHO 2007).

Salmon and Eels

If any fishes would be negatively affected by EMFs it would likely be species such as salmon and eels (both groups contain magnetite) which are known to migrate long distances with some accuracy, and the elasmobranchs (i.e., sharks, skates and rays), which contain sensitive electroreceptive organs that are used for prey detection and possibly for orientation or navigation.

Research into geomagnetic orientation in fish has focused on two groups that undergo long migrations: (i) salmon (both *Onchorhyncus* spp. and *Salmo* spp.), and (ii) eels of the genus *Anguilla*. Salmon hatch from freshwater spawning grounds then migrate out to sea where they can undergo extensive oceanic or coastal feeding migrations for hundreds or even thousands of kilometres. After spending their adult lives foraging and growing at sea, salmon migrate back to their natal rivers to spawn. *Anguilla* species have an opposite life cycle. The American eel (*A. rostrata*) migrates from rivers on the east coast to the Sargasso Sea. Newly spawned eels are carried in the North Atlantic Gyre where they disperse back to the rivers. The fact that salmon and eels undergo such long ocean migrations makes them likely candidates for a geomagnetic guidance system.

Laboratory experiments have been conducted with glass eels which were temporarily exposed to an artificial magnetic field in laboratory studies related to the SwePol HVdc cable in the Baltic (Westerberg 2000a). The induced magnetic field exceeded the natural magnetic field maximal by a factor of fifty. Even at the maximum level, the animals showed “no significant reactions.” Thus, Westerberg (2000a) assumed that cables that locally increase the magnetic field to 100 µT (100,000 nT) (approximately twice the Earth’s natural magnetic field in the North and Baltic seas) does not imply a significant barrier effect for glass eels. Similar investigations were carried out by Fock et al. (1999) for the EuroKabel/VIKING Cable (North Sea). The highest exposure levels in that laboratory experiment were 161.4 µT (161,400 nT), corresponding to 1 m vertical distance from the jetted cable. Even at this level, more than 85% of the glass eels crossed the artificially induced magnetic field.

Field studies with silver eels further confirmed the lack of a barrier to fish migration from subsea cables. Field studies were conducted by Westerberg and Begout-Anras (2000). In 1997 and 1998, the authors sonic - tagged 25 silver eels in the vicinity of an HVdc cable (Baltic Cable). A current of 1,000 to 1,300 A flowed constantly through the cable, inducing a magnetic field of 5 µT (5,000 nT) (10% of the Earth's magnetic field) at a distance of 60 m from the cable. About 60% of the eels crossed the cable in spite of the clear anomaly to the natural magnetic field. Only marginal changes in swimming direction while crossing the cable indicated any effect of the magnetic field generated by the cable.

The discovery of magnetite and the apparent sensory use of it in salmon generated interest and study in the 1960s. Since that time, research interest has waned and two major references on fish, *The Ocean Life of Atlantic Salmon* (Hansen and Jacobsen 2000) and *Marine Fisheries Ecology* (Jennings et al. 2001), only briefly refer to the possibility of a magnetic compass in fishes. In the review *Sensory Processing in Aquatic Environment*, Doving and Stabell (2003) sound a cautionary note on the idea of a "magnetic map" that could be used for navigation in fish:

> *"Before accepting that salmon make use of an assumed magnetic sense to form a hypothetical magnetic map, one should acknowledge the variations, or noise, in the Earth's magnetic field of several tens of nanoTeslas (nT) at any location, changing with a time scale of hours or days. These variations with time are in the same order of magnitude observed when moving 10 km in a north-south direction, or as the anomalies caused by natural variations of magnetic minerals in the bedrock (Dobrin and Savit 1988). In addition, both temporary variations due to magnetic storms (±200 nT), as well as the fixed magnetic anomalies (±200 nT) caused by the magnetic minerals in the oceanic crust, may cast doubt on the prospects of forming an applicable magnetic map. Elaborate corrections using modern computers are always carried out on magnetic survey data before magnetic maps can be produced. It is not likely that a fish has this capacity. It should be noted also, that such a map should not only be formed, but also memorized by the migrating animal. Capabilities of this kind have yet to be demonstrated in fishes..."*

Elasmobranchs

Electroceptive fishes are of most relevance in any discussion of the potential effects of EMFs in the marine environment. The principal group of electroreceptive fishes in the marine environment is the elasmobranchs (sharks, skates, and rays), and chimeras or deep sea ratfish. These fish contain ampullae of Lorenzini. Electroreceptor cells line the walls of the ampullae, and each has a synaptic contact with an electrosensory nerve fibre. The canals are filled with transparent, jelly-like mucopolysaccharides that have an electric resistance similar to surrounding seawater. In contrast, the walls of the canals, the intervening connecting tissue, and the skin of the fish have much higher electrical resistances. The canals act as electrical cables connecting receptor nerve cells deep within the fish with the outside medium. There are also inherent structural components of the ampullae that shunt high frequency fields away from basal receptor cells making them low frequency electroreceptive organs that are most sensitive to frequencies between 1 to 8 Hz (Bodznick et al. 2003).

It is well documented that elasmobranch ampullae are capable of detecting weak electric currents in seawater. Kalmijn (1966) showed that swimming sharks and rays exhibited avoidance responses when subjected to voltage gradients of 1 to 10 µV cm^{-1}. Sedate sharks and rays visibly responded to a square wave field of 5 Hz with a voltage gradient of 0.1 µV cm^{-1}. Changes in the heart rate of a ray were detected down to a voltage gradient of 0.01 µV cm^{-1}. The dogfish displayed behavioural responses to gradients as low as 5 nV/cm^{-1} (0.005 µV cm^{-1}) (Kalmijn 1982). The blacktip reef shark (*Carcharhinus melanopterus*) and whitetail stingray (*Himantura granulata*) both showed threshold responses at about 4 µV cm^{-1} (0.004 µV cm^{-1}) (Haine et al. 2001).

Elasmobranchs can detect dc electric fields but ampullae of Lorenzini are not dc receptors. Rather, the ampullae allow sharks and rays to detect changes in the surrounding electric field, making them ac receptors with an adaptation time constant of about 3 to 5 seconds (Kalmijn 2003). When a shark, skate, or ray moves in a straight line for more than 3 to 5 seconds at a constant velocity in a uniform dc field, its sense organs do not register the field. Ampullae can only detect ac changes in the field. The fish must actually explore and probe its surroundings by purposely varying its direction of travel. It is the unequal clustering of ampullae over the surface of the body that enables elasmobranchs to determine, by constant intra-ampullae comparison of microchanges in the surrounding field, the intensity, spatial configuration and direction of the electrical source.

Electrosensitivity may also be a function of the depth at which the animals live. The number and size of ampullae increase significantly with depth for skate species that live at depths ranging from 63 to 2,058 m. Species inhabiting deep regions of the ocean, where sunlight does not penetrate, possess higher numbers of receptor cells and may rely more heavily on electroreception than species in shallow regions (Raschi and Adams 1988).

Gill et al. (2005) concluded that while anthropogenic electric fields may repel (authors term a direct effect since it would affect migration) or attract (indirect effect since it would affect feeding success) electroreceptive fish there is presently no evidence to suggest significant adverse effects.

Despite the electrosensory capabilities of elasmobranchs, the effective range for detection of prey in nature is short because the electric fields produced by aquatic organisms are weak and the elasmobranch must pass close to the source to detect them. Haine et al. (2001) conducted electrosensory studies on the blacktip reef shark and whitetail stingray and found that both exhibited threshold responses at about 4 nV cm^{-1} (0.004 µV cm^{-1}).

The electric fields generated by invertebrates were size dependant with large specimens giving off stronger fields. For both invertebrates and fish, fields were strongest at their anterior ends presumably because of the closer proximity to physical and neural activity associated with feeding and respiratory processes. Peak fields were about 100 µV cm^{-1}, 25,000 times higher than the threshold level of the shark and skate. But electric potentials decreased significantly with distance. For the bivalve *Mactra* species (sp.), electric field intensity dropped 10 fold at a distance of 9 cm from the siphon. For the fish, decrease in potentials with distance from the mouth decayed with a relationship of $V \alpha 1/r^4$, where r is the radial distance in cm. Based on the interaction of multiple electric fields, Haine et al. (2001) calculated that the distance at which the source potential dropped below the detection level of the shark and ray was 250 cm.

At present, there are two types of plausible theories for elasmobranch navigation: (i) electroreceptive and (ii) geomagnetic. In the electroreceptive navigation model, the elasmobranch senses voltage gradients in its own body that it inductively generates as it swims through the Earth's geomagnetic field. The horizontal velocity of the animal interacts with the horizontal component of the geomagnetic field producing a vertical electromotive field. The theoretical advantage of this "active" model is that the movement of the fish itself gives it the capacity for directional navigation. Induced voltage is a function of the speed at which the conductor moves through a magnetic field and the angle that it cuts the lines of magnetic flux.

The Earth's geomagnetic field lines generally run in a north-south direction. A shark swimming in an easterly or westerly direction would move perpendicular to the Earth's field lines thereby generating the maximum voltage potential. Because the Earth's geomagnetic field lines are unidirectional (south to north poles), the induced voltage within the shark moving east would have a polarity the reverse of that in a shark swimming to the west. Swimming in a northerly or southerly direction, the fish would be moving parallel to the field lines and would not cross them which results in no voltage being generated. In this navigation model, north-east cannot be distinguished from south-east and north-west cannot be distinguished from south-west. The shark can determine which of the two possibilities is correct by sensing what happens when it turns. If the fish is swimming north-east and turns to the right, thereby increasing its angle of attack on the north - south geomagnetic field lines, induced voltage will increase. If it turns left and brings its course more parallel to field lines, induced voltage will decrease. Theoretically, the elasmobranch electrosensory system could provide it with 360° navigational ability.

Empirical evidence that elasmobranchs can detect magnetic fields is mostly limited to laboratory behavioural studies. Behavioural responses to shifts in geomagnetic fields have been documented for leopard sharks

(*Triakis semifasciata*), round stingrays (*Urolophus halleri*), sandbar sharks (*Carcharhinus plumbeus*), and scalloped hammerhead sharks (*Sphyrna lewini*) (Meyer et al. 2004; Kalmijn 1978). In field studies, there is evidence that hammerhead sharks in the Gulf of California exhibited movement patterns consistent with tropotaxis (movement or orientation of an organism in response to two stimuli, by means of different sense organs). Telemetry studies indicated that some individuals followed consistent foraging routes from their daytime resting area in the vicinity of a seamount to their nocturnal feeding grounds. While the pattern was unrelated to current patterns or bottom topography, more than a random number of routes were associated with sharp gradients in the local geomagnetic landscape. Klimley (1993) hypothesized that hammerheads could find seamounts using geomagnetic tropotaxis. The shark could be attracted to and move back and forth along ridges and valleys in the magnetic relief. If true, sharks were detecting and navigating along geomagnetic gradients that ranged from 0.0138 to 0.0374 nT m^{-1}. Meyer et al. (2004) demonstrated that elasmobranchs can detect magnetic fields of 25 to 100 µT (25,000 to 100,000 nT) against an ambient field of 36 µT (36,000 nT).

Change in Health of Macro-invertebrates and Fishes

Potential change in the health of macro-invertebrates and fishes during Operations and Maintenance of the submarine cables and electrode sites can be differentiated by mechanism. Direct injury and / or death could occur as a result of either submarine cable major repair operations or dredging at the electrode sites. Both of these activities could also cause re-suspension of sediment (i.e., increased seawater turbidity) which in turn could have harmful effects on both macro-invertebrates and fishes. Exposures to chemicals produced during electrolysis at the electrodes or electric fields and EMFs generated by the submarine cables and electrodes also have the potential to cause harmful effects to macro-invertebrates and fishes. Lastly, accidental releases of small amounts of potentially deleterious substances could also serve as sources of health change in these animals. However, all of these potential sources of health change in macro-invertebrates and fishes would have limited spatial and temporal effect, and thus affect only a small proportion of the macro-invertebrates and fishes in the LSA.

Assessment of Operations and Maintenance Effects on Fish

The primary likely effect of the operation of the submarine cables on macro-invertebrates and fishes relates to disturbance to their behaviours. The cables will emit EMFs which might be detectable by certain fish (e.g., elasmobranchs). Depending on the amount of disturbance, feeding and reproductive behaviours of macro-invertebrates and fishes in the immediate area could be affected. The operation of the shoreline electrodes has the potential to cause more effects than the submarine cable. In addition to emitting EMFs, electrolysis at the operating electrode site anode will change the chemistry of proximate water, thereby having potential to affect macro-invertebrate and fish health.

While routine inspection and maintenance of the marine components of the transmission system might temporarily disturb macro-invertebrates and fishes (e.g., ROV passing along the berms), major system repairs would have substantially greater effect on the Fish KI. Major repair of the submarine cable would likely require bringing a portion of the cable to surface, thereby disrupting a portion of the protective rock berm and potentially causing some mortality of macro-invertebrates and fishes in the area. Noise created by the major repair activities could potentially affect the local distribution of macro-invertebrates and fishes. The health of macro-invertebrates and fishes could also be compromised in the event of an accidental release of contaminants to the marine environment.

The activity associated with major repair work at the electrode sites that would have greatest effect on the Fish KI is dredging. Depending on the timing of dredging at the electrode sites, this activity could have higher potential to affect reproductive behaviour considering the proximity to typical spawning areas for some species (e.g., lobster, lumpfish).

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on the Fish KI are as follows:

- Adverse because of the emissions from the submarine cables (EMF) and shoreline electrodes (EMF and electrolysis);
- Low magnitude because the number of affected macro-invertebrates and fishes is likely to represent a small proportion of those same animals in the general vicinity;
- Limited to the LSA or just into the RSA;
- Far future duration because submarine cable and electrode emissions will occur throughout the Operations and Maintenance phase; and
- Continuous in frequency as inspection and maintenance will occur and EMFs will be generated throughout the Operation and Maintenance phase.

There is a low to moderate degree of confidence that the level of effect will not be greater than predicted because there is greater uncertainty with respect to some of the residual effects on the Fish relative to those discussed for the other two KIs. While there is little uncertainty associated with the likely residual effects on localized distributions and fish health, there is more uncertainty associated with the potential residual effects on specific behaviours. Uncertainties in the predictions are addressed in the EIS through conservative estimates and assumptions, monitoring and through adaptive management.

14.2.7 Environmental Effects Summary and Evaluation of Significance

To this point of the assessment of Project activities / components on the Marine Fish and Fish Habitat VEC, the analysis has been focused on the individual KIs associated with the VEC. This section compiles the KI assessment information and presents an overall conclusion for the Marine Fish and Fish Habitat VEC.

14.2.7.1 Summary of Environmental Effects

The summary of the environmental effects analysis is presented in Table 14.2.7-1. The overall likely environmental residual effect of Construction, and Operations and Maintenance activities associated with the Project on the Marine Fish and Fish Habitat VEC is minimal. In cases where duration is far future and frequency is continuous, the magnitude and extent are limited.

Table 14.2.7-1 Environmental Effects Analysis Summary: Marine Fish and Fish Habitat VEC

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Benthic Habitat	**Adverse** – Naturally occurring seabed habitat will be covered or altered, resulting in some injury and / or mortality of benthos.	**Low to Moderate** – Physical and chemical changes to Benthic Habitat will likely fall outside the normal range of variability but neither pose serious risk nor represent management challenge. <10% of the LSA naturally occurring seabed habitat will be covered or altered.	**Local** – Physical and chemical changes to Benthic Habitat will occur within the LSA.	**Short-term to Medium-term** – The re-establishment of benthic community productivity at locations of altered habitat will likely require more than 1 year but less than 4 years.	**Low** – The alteration of any particular Benthic Habitat will occur only once.
Marine Water Quality	**Adverse** – Seawater turbidity will increase.	**Low to Moderate** – Physical and chemical changes to Marine Water Quality will either fall within the normal range of variability or, if outside that range, neither pose serious risk nor represent a management challenge. – Modelling (AMEC 2011b) indicated that suspended sediment concentrations >100 mg/L due to rock placement will occur within a few hundred metres of the activity location.	**Local to Regional** – Depending on localized water movements, increased seawater turbidity will either occur within the LSA or extend a limited distance into the RSA. – Modelling (AMEC 2011b) indicated that suspended sediment concentrations >100 mg/L due to rock placement will last from 1 hour over 10.9 km^2 to about 100 hours over 1.3 km^2.	**Short-term** – Physical and chemical changes to Marine Water Quality at any particular location will last only a short time, at most a few days. – Modelling (AMEC 2011b) indicated that suspended sediment concentrations >100 mg/L due to rock placement will last from 1 hour over 10.9 km^2 to about 100 hours over 1.3 km^2.	**Low** – The alteration of any physical and chemical characteristics of seawater will occur only once.

Table 14.2.7-1 Environmental Effects Analysis Summary: Marine Fish and Fish Habitat VEC (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Fish	**Adverse** – There will be limited injury and / or mortality of macro-invertebrates, and possibly of fishes.	**Low** – The amount of injury / mortality of macro-invertebrates and fishes are expected to be minimal. There will likely be limited behavioural responses by macro-invertebrate and fish distributions but they will likely be temporary.	**Local to Regional** – While any macro-invertebrate and fish health effects will occur within the LSA, behavioural responses by these biota could extend into the RSA, particularly the ones caused by exposure to sound.	**Short-term** – Behavioural responses by macro-invertebrates and fishes will be temporary. While health effects can be permanent on an individual, the effect on the fish community is temporary.	**Low** – Injury / mortality of macro-invertebrates and fishes will occur only once during construction at any particular location within the LSA.
Summary of Likely Residual Construction Effects on Marine Fish and Fish Habitat: The ratings of all five effects descriptors are low to moderate for three KIs. Therefore, the overall residual effect of Construction activities on the Marine Fish and Fish Habitat VEC also reflect these low ratings. The effects of the Project Construction on the Marine Fish and Fish Habitat VEC are not likely to affect populations, distributions or activities (e.g., feeding, spawning, and migration) of species at a regional scale.					
Operations and Maintenance					
Benthic Habitat	**Adverse** – Naturally occurring seabed habitat will be covered or altered if major repair or dredging is required, resulting in injury and / or mortality of benthos. – Electric field, EMF and electrolysis product emissions could also affect health and / or behaviour of benthos.	**Low** – Physical, chemical and biological changes to Benthic Habitat will likely fall within the normal range of variability.	**Local** – Physical, chemical and biological changes to Benthic Habitat will occur within the LSA.	**Far Future** – Biological changes to Benthic Habitat could persist for the duration of operations, depending on the level of exposure to the EMF and electrolysis emissions.	**Continuous** – Biological changes to Benthic Habitat could occur continuously throughout operations, depending on the variability of the level of exposure to the EMF and electrolysis emissions.

Table 14.2.7-1 Environmental Effects Analysis Summary: Marine Fish and Fish Habitat VEC (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Marine Water Quality	**Adverse** – The introduction of EMF and chlorine to the seawater will change the Marine Water Quality from its natural state.	**Low** – Marine Water Quality change will likely only occur in a small volume of water.	**Local to Regional** – While EMF and chlorine introduction to seawater will only occur in the LSA, zooplankton responses to underwater sound, for example, could extend into the RSA.	**Far Future** – Introduction of EMF and chlorine to the seawater will persist for the duration of operations.	**Continuous** – Introduction of EMF and chlorine to the seawater will be continuous for the duration of operations.
Fish	**Adverse** – Naturally occurring seabed habitat will be covered or altered if major repair or dredging is required, resulting in injury and/or mortality of benthos. – Electric field, EMF and electrolysis product emissions could also affect health and / or behaviour of macro-invertebrates and fishes.	**Low** – The amount of behavioural and health effect on macro-invertebrates and fishes will likely be minimal.	**Local to Regional** – While any effect of exposure to EMF and chlorine will only occur in the LSA, macro-invertebrate and fish responses to underwater sound, for example, could extend into the RSA.	**Far Future** – Any effects of produced EMF and chlorine on macro-invertebrates and fishes could persist for the duration of operations.	**Continuous** – Any effects of produced EMF and chlorine on macro-invertebrates and fishes will be continuous for the duration of operations.
Summary of Likely Residual Operations and Maintenance Effects on Marine Fish and Fish Habitat: Although the duration and frequency of likely residual effects of Operations and Maintenance activities on the Marine Fish and Fish Habitat VEC would be constant due to electric fields, EMF and electrolysis chemical production at the cable and / or electrodes (as applicable), the extent of the effects will be limited in terms of magnitude and spatial extent. Considering this, the likely residual effects to habitat and fish populations resulting from the Operations and Maintenance of the Project will be minimal. The effects of the Project Operations and Maintenance on the Marine Fish and Fish Habitat VEC are not likely to affect populations, distributions or activities (e.g., feeding, spawning, and migration) of species at a regional scale.					

14.2.7.2 Definition and Determination of Significance

Based on the descriptions of the activities associated with Project Construction, and Operations and Maintenance, an understanding of the RSA baseline conditions and associated resilience of the Marine Fish and Fish Habitat VEC, an understanding of the residual effects on the Marine Fish and Fish Habitat VEC that will occur, and insight into the probability of occurrence of other identified potential effects, the Project's objective of preserving environmental integrity as it relates to the Marine Fish and Fish Habitat VEC, is obtainable.

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. For the purposes of this EIS, significant environmental effects on the Marine Fish and Fish Habitat VEC are those that affect more than 10% of the physical and biological components of the VEC occurring within the RSA for a period exceeding one year. The use of the 10% benchmark is fully justified. The Maximum Sustainable Yield (MSY) value used in fisheries science varies by species but is commonly in the 25% to 35% range. Zabel et al. (2003) argued that an Ecological Sustainable Yield (ESY) value would be a better measure in that it would simultaneously consider the effects on all species in an ecosystem. Work continues on this concept of ESY but it is reasonable to conclude that 10% is a conservative value to use in defining and determining significance of residual effects on the Marine Fish and Fish Habitat VEC for this Project.

The predicted effects of Project Construction, and Operations and Maintenance activities (e.g., loss of bottom habitat and associated change in benthic community structure and biotic injury due to rock berm construction and dredging, increased seawater turbidity due to rock berm construction and dredging, and invertebrate and fish behavioural responses to various underwater sounds and operations-related electric fields and EMFs emanating from the submarine cable and shoreline electrodes) will relate to less than 10% of bottom substrate, seawater and biota that occur in the RSA. The same can be expected for the potential effects (e.g., changes to seawater quality, sediment chemistry and biotic health due to electrode electrolysis products) that may not necessarily occur. Therefore, the Project is not likely to result in significant adverse environmental effects on the Marine Fish and Fish Habitat VEC.

14.2.8 Evaluation of Project Alternatives

Alternatives were considered as part of the Project design as discussed in Chapter 2, Section 2.12. No technically and economically feasible alternatives for the submarine cable crossing or the shoreline electrode sites were identified, and therefore Project alternatives are not evaluated for the Marine Environment.

14.2.9 Cumulative Environmental Effects

This section of the EIS assesses the overall effect on the Marine Fish and Fish Habitat VEC as a result of the Project's likely residual environmental effects in combination with those likely effects resulting from other projects and activities that will overlap both temporally and geographically within the RSA. The future projects and activities considered for the cumulative effects assessment included the potential future changes to the intensity / nature / distribution of fishing activity in the Strait of Belle Isle. Note, the Maritime Link listed in Table 9.3.9-2 for the Marine Environment is not considered in the cumulative effects assessment on the Marine Fish and Fish Habitat VEC as this development does not overlap spatially with the Project and is not in proximity to the RSA, and therefore no cumulative effects are likely. Table 14.2.9-1 presents the cumulative environmental effects summary associated with the Marine Fish and Fish Habitat VEC.

Table 14.2.9-1 Cumulative Environmental Effects Summary: Marine Fish and Fish Habitat VEC

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[(a)]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula[(b)]
Current (Baseline) **VEC Condition (Reflecting the Effects of Past and Ongoing Projects and Activities)**	n/a	– The current condition of the Marine Fish and Fish Habitat VEC in the Strait of Belle Isle RSA can be described as healthy and resilient. – Past and ongoing anthropogenic projects and activities that have affected Marine Fish and Fish Habitat in the Strait of Belle Isle RSA include commercial fishing, and vessel traffic (e.g., shipping, ferries, fishing, hunting).	n/a	n/a	– The current condition of the Marine Fish and Fish Habitat VEC in the Dowden's Point RSA can be described as healthy and resilient. – Past and ongoing anthropogenic projects and activities that have affected Marine Fish and Fish Habitat in the Dowden's Point RSA include commercial fishing, vessel traffic (e.g., shipping, ferries, fishing, hunting), operation of the Holyrood Generating Station, and relatively dense human habitation in the general vicinity.
Likely Residual Environmental Effects of Labrador-Island Transmission Link **(Reflecting Current VEC Condition, As Above)**	n/a	– The Project will result in the direct loss of natural bottom habitat and associated injury / mortality of some of the biota inhabiting this Strait of Belle Isle habitat. However, it is not likely to result in significant adverse environmental effects on the Marine Fish and Fish Habitat VEC in the Strait of Belle Isle RSA.	n/a	n/a	– The Project will result in the direct loss of natural bottom habitat and associated injury / mortality of some of the biota inhabiting the affected habitat at Dowden's Point. However, it is not likely to result in significant adverse environmental effects on the Marine Fish and Fish Habitat VEC in the Dowden's Point RSA.

Table 14.2.9-1 Cumulative Environmental Effects Summary: Marine Fish and Fish Habitat VEC (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula[b]
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	n/a	– All identified past and ongoing anthropogenic projects and activities have caused and will continue to cause effects on the Marine Fish and Fish Habitat VEC in the Strait of Belle Isle RSA that overlap identified effects of the Project on the VEC, particularly bottom substrate disturbance and introduction of underwater sound to the marine environment.	n/a	n/a	– All identified past and ongoing anthropogenic projects and activities have caused and will continue to cause effects on the Marine Fish and Fish Habitat VEC in the Dowden's Point RSA that overlap identified effects of the Project on the VEC, particularly bottom substrate disturbance and introduction of underwater sound to the marine environment.
Cumulative Environmental Effects Summary[c]	n/a	**Not Significant** – Due to the small area affected and the new habitat created, the cumulative effect of likely Project effects that overlap both temporally and geographically with other past, present and reasonably foreseeable projects and activities is not likely to be significant.	n/a	n/a	**Not Significant** – Due to the small area affected and the new habitat created, the cumulative effect of likely Project effects that overlap both temporally and geographically with other past, present and reasonably foreseeable projects and activities is not likely to be significant.

n/a Not applicable.
[a] Marine environment. Applicable to the Marine VECs only.
[b] For the Marine VECs, this area comprises the Dowden's Point electrode site only.
[c] Total (cumulative) change from the existing environment. Significance of cumulative effects evaluated using same definitions as for the Project Environmental Effects Analysis.

The effects of the Project in combination with other projects and activities that have been or will be carried out are not expected to affect more than 10% of the physical and biological components of the Marine Fish and Fish Habitat VEC occurring within the RSA for a period exceeding one year. Therefore, significant cumulative effects on the Marine Fish and Fish Habitat VEC are not likely to occur. The planning, consultative and effects management measures identified for this VEC will serve to avoid or reduce potential interactions and adverse effects as a result of the Project. Avoiding or managing potential effects on Marine Fish and Fish Habitat resulting from other ongoing and future projects and activities will require the appropriate resource management, planning, regulatory and enforcement measures are in place and implemented by the relevant agencies.

Additional mitigation measures are not considered to be necessary to eliminate or reduce cumulative effects on Marine Fish and Fish Habitat.

14.2.10 Monitoring and Follow-up

Monitoring of any compensation works as a result of Harmful Alteration, Disruption or Destruction (HADD) of marine fish habitat will be conducted according to a protocol acceptable to DFO. Initial monitoring (as-built monitoring) will be conducted to provide information on the structure of the compensation works, and subsequent effectiveness monitoring will also include a biological component to provide some measure of productivity occurring at the compensation works. The rock berms constructed as part of the Project will likely serve as some portion of the compensation works. Monitoring of the rock berms will be done using a remotely operated method such as ROV.

A follow-up program will be conducted by Nalcor to confirm effects prediction regarding EMFs that will be generated by the operating submarine cable and electrodes. This program would provide *in situ* gradient-to-background electromagnetic measurements at varying distances from the sources. Occurrence of biota would also be measured using the same gradient-to-background approach.

A follow-up program will be conducted to evaluate the level of production of electrolysis products at the electrode sites. This program would provide *in situ* gradient-to-background measurements of chemicals in the seawater and surficial sediment at varying distances from the electrodes. Occurrence of biota would also be measured using the same gradient-to-background approach.

The above monitoring and follow-up programs would be designed in consultation with DFO and other relevant parties such as the Newfoundland and Labrador Department of Fisheries and Aquaculture and Environment Canada, as appropriate. The findings of these programs will be considered in Nalcor’s adaptive management process as appropriate.

14.3 Marine Mammals and Sea Turtles

14.3.1 Introduction

The marine environment of Newfoundland and Labrador provides important foraging and / or breeding habitat for Marine Mammals and Sea Turtles. Twenty-two species of marine mammals may occur in the Strait of Belle Isle and Conception Bay, including 17 species of cetaceans and six species of Pinnipeds (see Table 10.5.9-1). Two sea turtle species have been recorded in the Strait of Belle Isle and Conception Bay. Most Marine Mammals and Sea Turtles use the area seasonally, and the region represents important foraging areas for many. Several marine mammal species and both sea turtle species that occur in the Strait of Belle Isle and Conception Bay are considered of special conservation concern by *SARA* and / or COSEWIC.

Marine mammals rely heavily on the use of underwater sounds to communicate and gain information about their environment. Studies have shown that this VEC is responsive to underwater noise and that some species, particularly Baleen Whales, often exhibit at least localized avoidance of areas with industrial activity. As such, this assessment focuses on the effects of underwater noise from Project activities on Marine Mammals and Sea Turtles.

14.3.2 Environmental Assessment Study Areas

14.3.2.1 Spatial Boundaries

The Local Study Area (LSA) has three components: the submarine cable crossing corridor in the Strait of Belle Isle (Corridor LSA Component) (Figure 14.3.2-1) and the two marine areas within a 500 m radius from the proposed shoreline electrode sites at L'Anse au Diable (L'Anse au Diable LSA Component) (Figure 14.3.2-1) in the Strait of Belle Isle, and Dowden's Point (Dowden's Point LSA Component) (Figure 14.3.2-2) in Conception Bay.

The Regional Study Area (RSA) consists of the Strait of Belle Isle RSA Component (Figure 14.3.2-1) and Dowden's Point RSA Component (Figure 14.3.2-2). A relatively large area was selected for the Strait of Belle Isle RSA Component given that the proposed submarine cable crossing corridor overlaps a migratory route for marine mammals and that some construction sounds from the Project will propagate beyond the Corridor LSA Component. A much smaller area (10 km radius around Dowden's Point) was selected for the Dowden's Point RSA Component because few Marine Mammals and Sea Turtles are expected to occur near Dowden's Point and marine construction and operation activities associated with the Dowden's Point electrode site are expected to be less intense and produce much less noise than the construction of the submarine cable crossings of the Strait of Belle Isle.

14.3.2.2 Temporal Boundaries

The temporal boundaries for the EA encompass a four-year period for the Project Construction phase, and an indefinite period for the Project Operations and Maintenance phase.

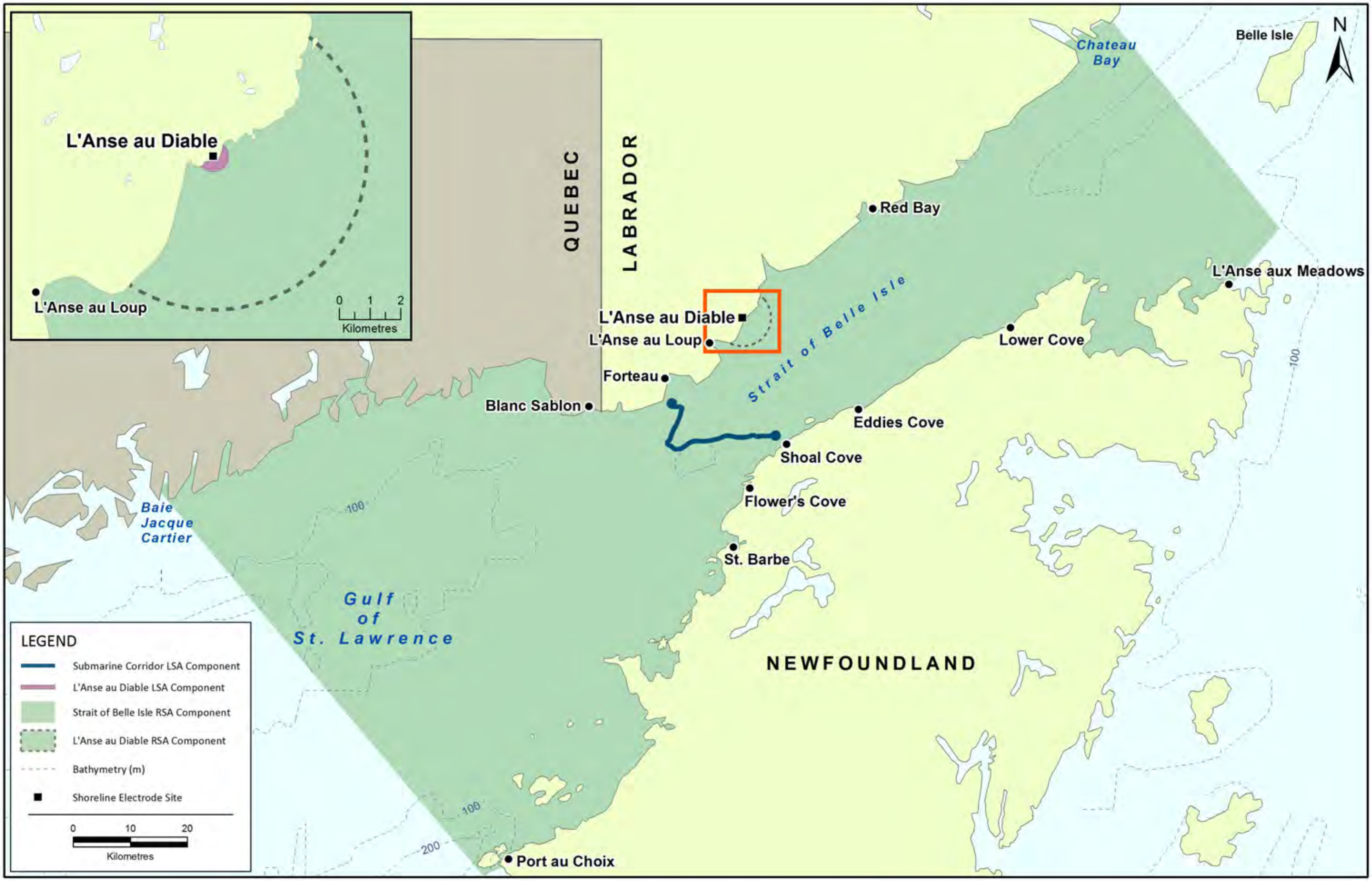
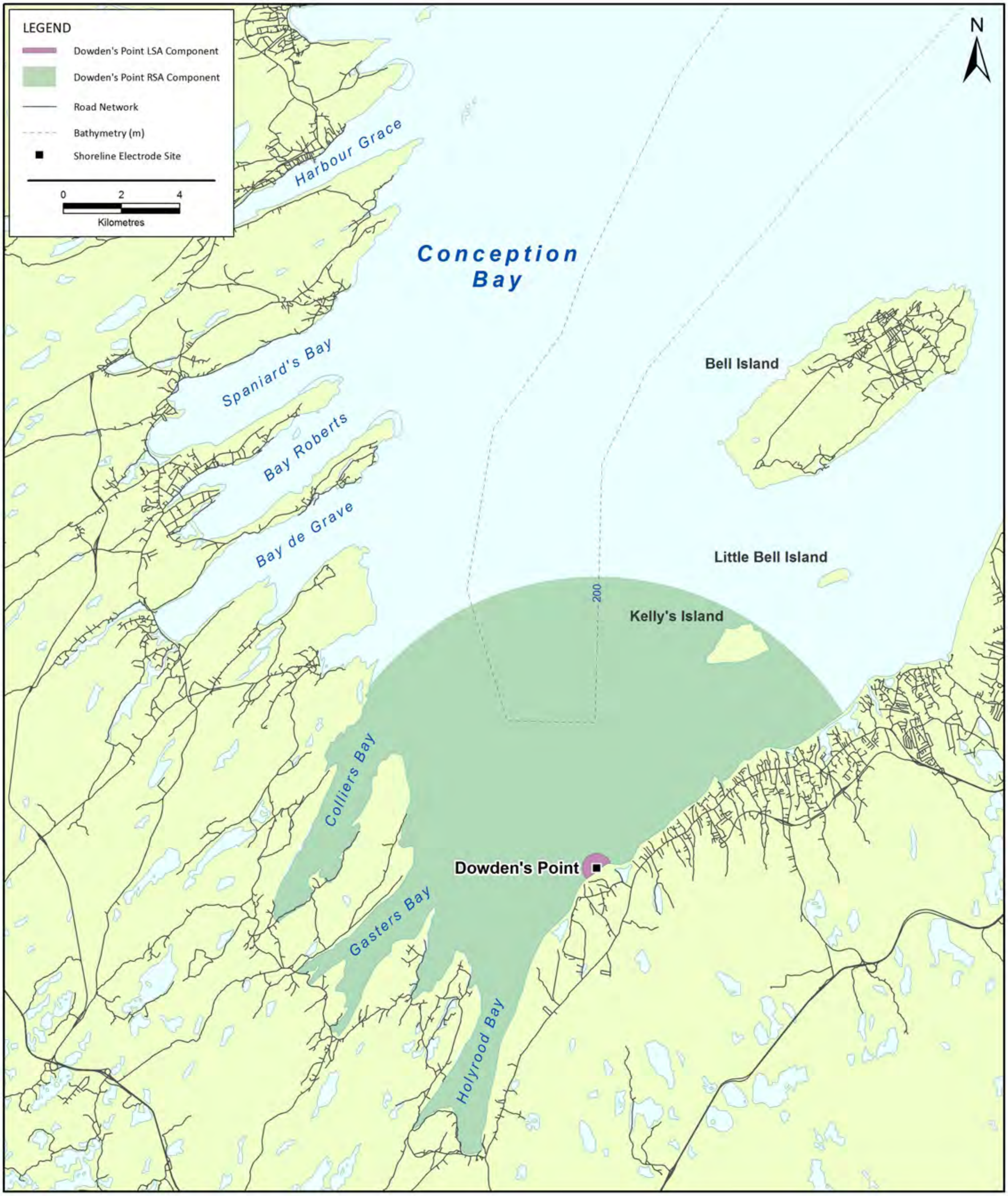


FIGURE 14.3.2-1

Marine Mammal and Sea Turtle Local Study Area (LSA) and Regional Study Area (RSA) Components in the Strait of Belle Isle Area



nalcor energy

FIGURE 14.3.2-2

Marine Mammal and Sea Turtle Local Study Area (LSA) and Regional Study Area (RSA) Components in the Dowden's Point Area, Conception Bay, Newfoundland

14.3.3 Potential Environmental Issues, Indicators and Interactions

14.3.3.1 Potential Environmental Issues

Issues and questions related to the Marine Mammals and Sea Turtle VEC that were identified in the EIS Guidelines and Scoping Document (May 2011), through regulatory, Aboriginal and stakeholder consultation, and by the EIS study team, are presented in Table 14.3.3-1. The nature and rationale as well as specific considerations for each issue / question are also included in Table 14.3.3-1.

The EIS Guidelines and Scoping Document (May 2011) requested a comprehensive analysis of the effects on marine mammals associated with:

- installation and operation of the Strait of Belle Isle cable crossing;
- sound produced from Project activities, particularly the effects on migrating marine mammals in the Strait of Belle Isle; and
- installation and operation of electrodes, including any long-term effects.

During consultations, similar issues were raised by stakeholders for both Marine Mammals and Sea Turtles, including species at risk.

The EIS study team determined that the effects of Project activities on marine mammal and sea turtle foraging should also be assessed as well the potential effects on marine mammal and sea turtle health. There is potential (albeit limited) for this VEC to experience hearing impairment and injury / mortality related to underwater noise and vessel collisions, respectively, from Project activities.

Table 14.3.3-1 Identified Issues and Questions: Marine Mammals and Sea Turtles

Issue / Question	Nature and Rationale	Specific Considerations
Underwater noise produced during the construction phase from vessels, drilling, dredging, and berm construction at electrode sites. Will it cause Marine Mammals and Sea Turtles to avoid the area?	Underwater noise may affect marine mammal and sea turtle migration routes / timing and cause avoidance of feeding areas.	Migration through the Strait of Belle Isle in spring and fall for certain marine mammals. Also, humpback whales are known to forage in relatively high numbers in an area that includes the Strait of Belle Isle LSA.
Underwater noise produced during the construction phase from vessels, drilling, dredging, and berm construction at electrode sites. Will it cause hearing impairment?	Exposure to continuous underwater sound from construction activities may lead to hearing impairment in Marine Mammals and Sea Turtles if these animals occur close enough to the sound source.	Vessels operating dynamic positioning thrusters produce strong, low-frequency sound that is of particular concern for Baleen Whales.
Potential for collisions between Project vessels and the VEC. Will it result in mortality or injury?	Injury and mortality can result from vessel collisions, particularly if vessels are travelling at high speeds.	Particular concern for slower moving Baleen Whales. Blue whales are listed as Endangered on Schedule 1 of *SARA*.
Electromagnetic emissions from the electrodes. Will it affect sea turtle behaviour?	Some Sea Turtles may use existing, natural electromagnetic fields (EMFs) for navigational purposes and sea turtle behaviour may be affected by electromagnetic emissions.	Leatherback Sea Turtles are listed as Endangered on Schedule 1 of *SARA*. Loggerhead Sea Turtles are designated as Endangered by COSEWIC.

14.3.3.2 Key Indicators and Measurable Parameters

Four KIs have been selected for the Marine Mammals and Sea Turtles VEC: (i) Baleen Whales; (ii) Toothed Whales; (iii) Pinnipeds; and (iv) Sea Turtles (Table 14.3.3-2). All four KIs are present within the LSA and RSA, are good indicators of the status of the Marine Mammals and Sea Turtles VEC, and have available information associated with them. In addition, several species within the KIs are listed as Endangered on Schedule 1 of *SARA* and / or designated at risk by COSEWIC. Further rationale for the selection of each KI is provided in Table 14.3.3-2. All identified issues / questions noted in Table 14.3.3-1 are addressed during the assessment process using the KIs. If any KI is affected as a result of the Project, an effect on the VEC would also occur.

A KI must have associated MPs which are relevant and reflect the potential effects of the Project on the Marine Mammals and Sea Turtles VEC. The MPs selected for the four KIs described above and the rationale for their selection are included in Table 14.3.3-2. In short, with the exception of the Pinniped KI, four MPs were selected for each KI and include changes in: migration behaviour, feeding behaviour, hearing, and abundance. The abundance MP refers to changes in overall abundance of a KI as a result of potential mortalities or serious injury from collisions with Project vessels. This MP was not included for Pinnipeds because this KI is not considered at risk from vessel collisions in open water given their small size and ability to manoeuvre and avoid vessels.

Table 14.3.3-2 Key Indicators and Associated Measurable Parameters: Marine Mammals and Sea Turtles

Key Indicator	Rationale for Key Indicator[(a)]	Measurable Parameter[(b)]	Rationale for Measurable Parameter
Baleen Whales	– Vessel and construction noise are expected to affect Baleen Whale behaviour – It is possible that some whales may be exposed to sound levels or physical interactions with vessels that affect their health	– Migration behaviour – Feeding behaviour – Hearing – Abundance	– Timing and location of migration may change as a result of avoidance of Project activities (e.g., vessels, drilling, rock laying) – Baleen Whales may avoid preferred feeding areas as a result of Project activities (e.g., vessels, drilling, rock laying) – Studies have suggested that Baleen Whales may experience hearing impairment from underwater sounds – Baleen Whale abundance may change as a result of collisions with Project vessels (i.e., reduction in overall abundance due to mortality)

Table 14.3.3-2 Key Indicators and Associated Measurable Parameters: Marine Mammals and Sea Turtles (continued)

Key Indicator	Rationale for Key Indicator[(a)]	Measurable Parameter[(b)]	Rationale for Measurable Parameter
Toothed Whales	– Vessel and construction noise are expected to affect Toothed Whale behaviour – It is possible that some Toothed Whales may be exposed to sound levels or physical interactions with vessels that affect their health	– Migration behaviour – Feeding behaviour – Hearing – Abundance	– Timing and location of migration may change as a result of avoidance of Project activities (e.g., vessels, drilling, rock laying) – Toothed Whales may avoid preferred feeding areas as a result of Project activities (e.g., vessels, drilling, rock laying) – There are studies that have linked hearing impairment in Toothed Whales with underwater sound levels – Toothed Whale abundance may change as a result of collisions with Project vessels (i.e., reduction in overall abundance due to mortality)
Pinnipeds	– Vessel and construction noise may affect Pinniped behaviour – It is possible that some Pinnipeds may be exposed to sound levels from vessels that affect their health	– Migration behaviour – Feeding behaviour – Hearing	– Timing and location of migration may change as a result of avoidance of Project activities (e.g., vessels, drilling, rock laying) – Pinnipeds may avoid preferred feeding areas as a result of Project activities (e.g., vessels, drilling, rock laying) – There are studies that have linked hearing impairment in Pinnipeds with underwater sound levels
Sea Turtles	– Vessel and construction noise as well as electromagnetic emissions may affect Sea Turtle behaviour – It is possible that some Sea Turtles may be exposed to sound levels or physical interactions with vessels that affect their health	– Migration behaviour – Feeding behaviour – Hearing – Abundance	– Timing and location of migration may change as a result of avoidance of Project activities (e.g., vessels, electromagnetic emissions) – Sea Turtles may avoid preferred feeding areas as a result of Project activities (e.g., vessels, electromagnetic emissions) – There are studies that have linked hearing impairment in Sea Turtles with underwater sound levels – Sea Turtle abundance may change as a result of collisions with Project vessels (i.e., reduction in overall abundance due to mortality)

[(a)] Key Indicator: An aspect or characteristic of the VEC and / or its environment which, if changed as a result of the Project, may result in an effect on the VEC.
[(b)] Measurable Parameter: An environmental characteristic which is related to the status of a KI. Project effects to an MP can be detected and measured, typically as changes relative to baseline conditions.

14.3.3.3 Potential Project-Marine Mammals and Sea Turtles Interactions

The potential interactions of Project activities and the Marine Mammals and Sea Turtles VEC KIs are indicated in Table 14.3.3-3.

During the Construction phase of the Project, there is potential for interactions between two Project components and all four KIs of this VEC. The two Project components are: (i) construction and installation of submarine cables (marine works); and (ii) electrode site preparation and installation. In addition, it is possible that the Pinniped KI (i.e., seals hauled out on the shoreline) may interact with the "preparation and construction of submarine cable landing sites (on-land works)" component of the Project. There may be direct effects on KI behaviour and health and indirect effects on prey availability from Construction phase Project activities.

During the Operations and Maintenance phase of the Project, there is potential for interactions between four Project components and all four KIs of the Marine Mammal and Sea Turtle VEC. The four Project components are: (i) presence and operation of the transmission system; (ii) routine line inspections and repairs; (iii) potential major system repairs, and (iv) operation of the electrodes. There may be direct effects on KI behaviour and health and indirect effects on prey availability from Operations and Maintenance phase Project activities.

Table 14.3.3-3 Potential Project Interactions: Marine Mammals and Sea Turtles

Project Component / Activity	Key Indicator			
	Baleen Whales	**Toothed Whales**	**Pinnipeds**	**Sea Turtles**
Construction				
Construction access trails and roads	–	–	–	–
Movement and presence of personnel, equipment and materials				
Construction camps				
Marshalling yards and staging areas				
Right-of-way clearing and preparation				
Quarrying and burrowing				
Transmission tower assembly and installation				
Conductor installation				
Converter station site preparation and construction				
Preparation and construction of submarine cable landing sites (on-land works)			– Airborne noise could affect behaviour of hauled out seals	

Table 14.3.3-3 Potential Project Interactions: Marine Mammals and Sea Turtles (continued)

Project Component / Activity	Key Indicator			
	Baleen Whales	**Toothed Whales**	**Pinnipeds**	**Sea Turtles**
Construction and installation of submarine cables (Marine works)	– Underwater noise may affect behaviour and hearing – Underwater noise may mask[(a)] communication – Collisions with vessels may occur – Accidental spills may affect health – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour and hearing – Underwater noise may mask communication – Collisions with vessels may occur – Accidental spills may affect health – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour and hearing – Underwater noise may mask communication – Accidental spills may affect health – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour and hearing – Collisions with vessels may occur – Accidental spills may affect health
Electrode site preparation and installation	– Underwater noise could affect behaviour – Underwater noise may mask communication – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour – Underwater noise may mask communication – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour – Underwater noise may mask communication – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour
Island system upgrades	—	—	—	—
Employment / presence of workers				
Contracting / expenditures				
System commissioning				
Operations and Maintenance				
Operations / Maintenance access trails and roads	—	—	—	—

Table 14.3.3-3 Potential Project Interactions: Marine Mammals and Sea Turtles (continued)

Project Component / Activity	Key Indicator			
	Baleen Whales	**Toothed Whales**	**Pinnipeds**	**Sea Turtles**
Presence and operation of the submarine cable	– EMFs may affect behaviour	– EMFs may affect behaviour	– EMFs may affect behaviour	– EMFs may affect behaviour
Routine line inspections	– Underwater noise could affect behaviour – Underwater noise may mask communication – Accidental spills may affect health	– Underwater noise could affect behaviour – Underwater noise may mask communication – Accidental spills may affect health	– Underwater noise could affect behaviour – Underwater noise may mask communication – Accidental spills may affect health	– Underwater noise could affect behaviour – Accidental spills may affect health
Vegetation management	—	—	—	—
Potential major system repairs	– Underwater noise could affect behaviour – Underwater noise may mask communication – Accidental spills may affect health – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour – Underwater noise may mask communication – Accidental spills may affect health – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour – Underwater noise may mask communication – Accidental spills may affect health – Prey distribution and abundance may be affected	– Underwater noise could affect behaviour – Accidental spills may affect health
Operation of the electrodes	– EMFs may affect behaviour – Prey distribution and abundance may be affected	– EMFs may affect behaviour – Prey distribution and abundance may be affected	– EMFs may affect behaviour – Prey distribution and abundance may be affected	– EMFs may affect behaviour – Prey distribution and abundance may be affected
Employment / presence of workers	—	—	—	—
Contracting / expenditures				

— No likely or detectable interaction identified.

[a] Masking occurs when the perception of biologically-important sounds is decreased due to interference by sound energy from other sources (including ambient noise). Masking is most pronounced if the interfering sound overlaps in frequency with the sound signal of interest.

14.3.4 Approach to the Environmental Effects Analysis

14.3.4.1 Analytical Methods

Baseline conditions of the Marine Mammals and Sea Turtles VEC were determined using various approaches, including field work conducted for the Project (Jasco 2011b; Sikumiut 2011c; Jacques Whitford and Kingsley 2000), inclusion of field data collected in the RSA during studies not associated with the Project, review of government databases, and review of primary and grey literature. The literature was also reviewed to determine how Marine Mammals and Sea Turtles respond to activities similar to those that will occur during the Project. Acoustic and electromagnetic modelling were conducted to provide quantitative information on the Project specific activities to be used in the assessment of Project effects on this VEC. The results of the modelling were compared with relevant literature to assess the effects.

Acoustic Modelling

Acoustic modelling was conducted to estimate underwater sound levels from Construction activities associated with the submarine cable installation across the Strait of Belle Isle. The modelling involved two studies both conducted by Jasco Applied Research (Jasco) (2011a, b).

Jasco (2011b) involved the collection of acoustic ambient data during 2010. The acoustic data were recorded at three locations along or near the cable crossing corridor. Acoustic recorders were deployed that recorded sounds at these three locations from June to August and from September to December 2010. The purpose of the *Strait of Belle Isle: Ambient Noise and Marine Mammal Survey* was to provide a baseline of existing sound types and levels in the Strait of Belle Isle.

In addition to collecting baseline data, Jasco prepared *Sound Modelling: Proposed Strait of Belle Isle Cable Installation Activities* (Jasco 2011a), which was undertaken to estimate and describe potential sound levels resulting from the Construction activities associated with underwater cable installation in the Strait of Belle Isle. Acoustic propagation from five activities were considered: (i) horizontal directional drilling (HDD) (from on-land at Forteau Point, Labrador and Shoal Cove, Newfoundland and out under the Strait), (ii) transit of cable-laying vessel, (iii) operations of cable-laying vessel in dynamic positioning mode, (iv) transit of rock-placement vessel, and (v) operations of rock-placement vessel in dynamic positioning mode. Vessel transit and operations were modelled at four locations along the submarine cable crossing corridor. The sound propagation model used acoustic parameters specific to the geographic region of interest, including water column sound speed profile, bathymetry, and bottom geoacoustic properties, to produce site-specific estimates of the radiated noise field as a function of range and depth. The acoustic footprint and maximum distance (range) to underwater sound pressure level isopleths between 200 to 120 dB re 1 µPa root mean square (rms) were determined for each activity. Further, the predicted sound levels were compared with the ambient noise level values measured as part of *Strait of Belle Isle: Ambient Noise and Marine Mammal Survey* (Jasco 2011b). The loudest sound source at each modelling site was considered for comparison. The quietest, 95th percentile ambient noise spectrum, was selected as the baseline.

Electromagnetic Modelling

Magnetic fields are produced by the flow of current through cables and conductors, and also as electric current passes through other media such as the sea and soil. The magnitude of the magnetic field at a given point is dependent on the distance from the conductor, and the permeability of the medium. Hatch Ltd. (2011) modelled the electromagnetic field for both electrode sites for electrode current at nominal levels during normal bipolar operations (e.g., <1% of the current) and during monopolar operations (e.g., 100% of the current). The magnetic field modelling is based on the Ground Potential Rise (GPR) gradient model used for the electric field modelling. The magnetic field modelling was calculated at the surface as this represents the greatest EMF, as it decreases with depth in the present scenario.

The magnetic field around the submarine cables was also calculated with consideration of the design specifications of the cable (e.g., the amour layers and the protective rock berm) at various distances from the cable using the Bio-Savart formula (Worzyk 2009).

Marine Mammals and Sea Turtles VEC Effects Analysis

The literature was reviewed to determine the received sound levels from ships known or expected to elicit certain behavioural and physiological responses in Marine Mammals and Sea Turtles. This information was used to establish sound level criteria and then the corresponding maximum distances were derived from the acoustic modelling results presented in Jasco (2011a). This allowed the estimation of zones of influence and hence, the geographic extent and magnitude of a predicted effect. In addition, EMF modelling results were examined relative to the literature on marine mammal and sea turtle abilities to detect EMFs.

The VEC effects analysis uses a structured and rigorous approach that includes an appropriate combination of quantitative and qualitative methods. The analysis considers the nature and degree of Project-induced change from the existing environment (baseline conditions). During the assessment process, appropriate mitigation measures are identified to minimize the effects that could result from the interactions between Project activities and the Marine Mammals and Sea Turtles VEC. The effects assessment is based on the Project with mitigation in place. Descriptors to be used in the residual effects analysis are discussed in the following section.

14.3.4.2 Environmental Effects Descriptors

Five descriptors are used to assess the residual effects of the Project on the KIs of the Marine Mammals and Sea Turtles VEC: (i) direction; (ii) magnitude; (iii) geographic extent; (iv) duration; and (v) frequency. Each descriptor is characterized by at least three ratings that provide further clarification of the descriptor of any particular residual effect. The definitions of the ratings of environmental residual effects descriptors for the Marine Mammals and Sea Turtles KIs are provided in Table 14.3.4-1. The definitions apply to all four KIs of this VEC.

Table 14.3.4-1 Effects Descriptors: Marine Mammals and Sea Turtles

Effects Descriptor	Definition
Direction	
Adverse	Undesirable effect on KI
Neutral	No effect on KI
Beneficial	Desirable effect on KI
Magnitude	
Low	Effect on KI within normal range of variability
Moderate	Effect on KI unlikely to pose serious risk to the VEC or represent management challenge
High	Effect on KI likely to pose serious risk to the VEC and represent management challenge
Geographic Extent	
Local	Effect on KI limited to the Local Study Area
Regional	Effect on KI limited to the Regional Study Area
Beyond regional	Effect on KI extends beyond the Regional Study Area
Duration	
Short-term	Effect on KI persists for ≤1 year
Medium-term	Effect on KI persists for >1 to ≤4 years
Long-term	Effect on KI persists for >4 to ≤30 years
Far future	Effect on KI will be evident throughout the Project
Frequency	
Low	Effect on KI occurs not more than once per year
Moderate	Effect on KI occurs 2 to 10 times per year
High	Effect on KI occurs more than 10 times per year
Continuous	Effect on KI is continuous

14.3.5 Construction

14.3.5.1 Overview of Project Construction and Associated Effects Management

During the Construction phase, the underwater noise produced by ships involved with cable laying and rock berm construction have the most potential to affect Marine Mammals and Sea Turtles. This VEC may also be affected by horizontal directional drilling of the subsea conduits from the cable landing sites out and under the Strait of Belle Isle. Construction activities at the electrode sites (construction of permeable rock berms and dredging) will also introduce underwater sound into the marine environment and potentially affect the Marine Mammals and Sea Turtles VEC. Mitigation measures for ship activities are expected to minimize the effects of the Project on this VEC. There is also potential for Construction activities to cause changes in marine mammal and sea turtle health if there are accidental releases of small amounts of deleterious substances (e.g., hydrocarbons). However, this effect is not analyzed in detail given the low probability of occurrence (with proper mitigation measures in place) and the low likelihood that Marine Mammals and Sea Turtles would come in contact with deleterious substances given their tendency to avoid at least the immediate area around vessels.

Mitigation measures of Project activities during the Construction phase that will minimize effects on the Marine Mammals and Sea Turtles VEC include:

- Project vessels will maintain constant course and speed whenever possible;
- Project vessels will detour around Marine Mammals and Sea Turtles if feasible;
- construction will be completed as quickly as safety allows, thus decreasing the amount of vessel noise;
- vessels will be outfitted, operated and maintained to limit the potential for inadvertent releases of contaminants (e.g., oil) and proper protocols will be implemented to avoid accidental introduction of potentially deleterious substances to the marine environment including all applicable regulations to minimize effects on seawater;
- biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies;
- spill kits and trained personnel will be present on-site at all times, allowing for prompt containment;
- a spill response team will be formed and trained;
- spills will be reported to the appropriate authority;
- fuelling or servicing or mobile equipment on-land will not be permitted within 50 m of a waterbody;
- the SHERP (Safety, Health and Environment Emergency Response Plan) will contain spill prevention and response plans; and
- the EPP (Environmental Protection Plan) will contain conditions for fuel handling and storage, including procedures for spill response.

14.3.5.2 Existing Knowledge

There have been no direct or systematic studies of the effects of cable laying and underwater berm Construction on Marine Mammals and Sea Turtles. There is limited information on the effects of drilling (associated with hydrocarbon developments) on this VEC. There is, however, relevant literature on the effects of vessels, including those operating dynamic positioning thrusters, on Marine Mammals and Sea Turtles. The existing knowledge on this topic is reviewed in the effects assessment of Construction activities below.

14.3.5.3 Construction Effects: Baleen Whales

Behavioural Responses to Vessel Traffic and Drilling

The behavioural effects of exposure to underwater sound on Marine Mammals and Sea Turtles are issues / questions which have been raised in relation to the Project. Some understanding of the fundamentals of underwater sound is required to enable interpretation of potential effects; background information is provided below on this topic. In addition, background information is provided on Baleen Whale hearing, particularly the sound frequencies this marine mammal group is theorized to be the most sensitive.

Background Information on Underwater Sound

Most treatments of the effects of underwater sound are based on the Source-Path-Receiver concept. In the case of the proposed Project, there are several sound sources (e.g., marine vessels, drilling, dredging). Seawater is an efficient medium through which sounds can travel long distances and represents the path. The receiver of these sounds is a marine animal of interest. The sounds received are dependent on the amount of propagation loss that occurs between the source and the receiver. The ability of the receiver to detect these signals depends on the hearing capabilities of the species in question, as well as the amount of ambient or background noise in the sea around the receiver. The sea is a naturally noisy environment, and the ambient noise can mask weak signals from distant sources (Richardson et al. 1995).

Acousticians use a logarithmic scale for sound intensity and denote the scale in decibels (dB). In underwater acoustics, sound is usually expressed as a Sound Pressure Level (SPL):

$$\text{Sound Pressure Level} = 20 \log (P/Po)$$

P represents the pressure and Po is a reference level, usually 1 µPa. As other reference levels have also been used in the past, the reference level needs to be shown as part of the SPL unit. In this scale, a doubling of the sound pressure means an increase of 6 dB. For example, a pressure (P) of 1,000 Pa has a SPL of 180 dB re 1 µPa whereas a pressure of 500 Pa has a SPL of 174 dB re 1 µPa. To interpret quoted SPLs, one must also have some indication of where the measurement applies. SPLs are usually expressed as either received sound levels at the receiver location or as sound levels at the source. A source level is usually calculated or measured as the SPL at 1 m distance from the source. The SPL can be expressed in different metrics: the difference in pressure between the highest positive pressure and the lowest negative pressure is the peak-to-peak pressure (p-p). The peak positive pressure, usually called the peak or zero to peak pressure (0-p), is approximately half the peak-to-peak pressure. The average pressure recorded during the pressure pulse can be expressed as the rms or average pressure. The rms pressure is integrated over the duration of the sound signal. A difficulty with this type of measurement is that it is often hard to interpret because it depends on the averaging time.

More recently, some sounds have been measured as Sound Exposure Levels or SELs. This is directly proportional to the total energy density of the acoustic signal. Energy is proportional to the time integral of the pressure squared. Hence, SEL includes time as a dimension and is expressed as μPa^2-s. Energy levels are not directly comparable to pressure levels. In most cases, energy values are less than "average pressure squared over the pulse duration", measured in dB re 1 µPa, but the difference is variable. As most of the literature on effects of sound on marine animals is presented as SPLs, the discussion in this EIS focuses on pressure levels (Richardson et al. 1995).

Sound measurements are often expressed as broadband, meaning the overall level of the sound over a range or band of frequencies. The level at a specific frequency will be lower than the broadband sound level for some bands containing that frequency because the broadband sound includes the components over a wide range of frequencies. Sound signatures consist of measurements of the sound level at each frequency (a sound spectrum). Sound level can also be measured and summed over groups or bands of frequencies (e.g., octaves or third octaves) (Richardson et al. 1995). Unless otherwise indicated SPLs included below are presented as rms levels.

Background Information on Baleen Whale Hearing

The hearing abilities of Baleen Whales have not been studied directly. Behavioural and anatomical evidence indicates that they hear well at frequencies below 1 kHz (Ketten 2000; Richardson et al. 1995). In addition, Baleen Whales produce sounds at frequencies up to 8 kHz and, for humpback whales, with components >24 kHz (Au et al. 2006). The anatomy of the Baleen Whale inner ear seems to be well adapted for detection of low-frequency sounds (Parks et al. 2007; Ketten 2000, 1994, 1992, 1991). Although humpbacks and minke whales may have some auditory sensitivity to frequencies above 22 kHz (Berta et al. 2009), for Baleen Whales as a group, the functional hearing range is thought to be about 7 Hz to 22 kHz (Southall et al. 2007).

Review of Baleen Whale Behavioural Responses to Vessel Traffic and Drilling

There have been many studies of Baleen Whale response to vessel traffic. Richardson et al. (1995) provide a thorough review of studies up to 1995 and Southall et al. (2007) provides a more recent review that focuses on studies where received sound levels were measured or estimated. Overall, Baleen Whale response to vessel traffic depends on several factors including the distance between the whale and the vessel, the speed and course of the vessel, the activity a whale is engaged in at the time of exposure, and the species. The following text focuses on reviews of studies of Baleen Whale species found in the RSA.

Reactions of humpback whales to boats are variable, ranging from approach to avoidance (Salden 1993; Payne 1978). In south-east Alaska, concern was raised that increasing vessel traffic in Glacier Bay National Park may have caused humpbacks to leave the bay, particularly early in 1978 (Jurasz and Jurasz 1979). A subsequent detailed study confirmed that humpbacks often move away when vessels are within several km (Baker and Herman 1989; Baker et al. 1983, 1982), although reactions of humpbacks vary considerably. Estimates of received levels (RLs) indicated some behavioural avoidance by humpback whales at the 110 to 120 dB re 1 µPa range and clear avoidance at 120 to 140 dB re 1 µPa (Southall et al. 2007). Humpbacks seem less likely to react overtly when actively feeding than when resting or engaged in other activities (Krieger and Wing 1986, 1984).

More recent studies of humpback whale responses to approaching vessels have been carried out on breeding grounds. Off the coast of mainland Ecuador, humpback whales were found to react to the approach of whale-watching boats by increasing swim speeds significantly (Scheidat et al. 2004), and behavioural responses including abrupt course changes and long dive times have also been reported for humpback whales in Hawaiian waters (Green 1998 in Nowacek et al. 2007).

The response of humpback whales to whale-watching vessels in Hervey Bay, Australia was monitored in 1994 in an attempt to develop design criteria for vessels to minimize disturbance to whales (McCauley and Cato 2001). It was found that rapid increases in vessel noise produced more responses by humpbacks. Results indicated clear avoidance of vessels by humpbacks at RLs between 118 to 124 dB re 1 µPa (McCauley et al. 1996). The behaviour of southward migrating humpback whales in Hervey Bay in response to whale-watching vessels was also monitored in 1988 and 1989 (Corkeron 1995). Whale pods, both with and without calves, were more likely to dive rather than slip beneath the water surface within 300 m of the vessels. Corkeron (1995) indicates that it is uncertain whether short-term behavioural changes would be accompanied by longer-term avoidance. This study provides no information on the types of whale-watching vessels or their sound levels.

Au and Green (2000, 1997) concluded that it was unlikely that the sound levels from whale-watching vessels would have serious effects on humpback whales in Hawaiian waters. They found that whale-watching vessels had source levels only 8 to 10 dB stronger than the level of background humpback whale sounds produced at the peak of the whale season (Au and Green 2000).

The vocal activity of humpback whales may change in response to approaches by motor boats. Two humpback whales sang shorter versions of their songs when exposed to engine noise and three humpbacks interrupted their songs after the motor boat switched gears but resumed singing when the motor was in neutral (Sousa-Lima et al. 2002). Sample size was small in this study.

Relative to humpback whales, there is limited information available about the reactions of rorquals (fin, blue, minke whales) to vessels, but in general, reactions to vessels are varied. Based on a study of fin whale response to a small (4.5 m long) inflatable boat powered by a 25 horsepower (hp) outboard engine, Jahoda et al. (2003) recommended that exposure of fin whales (in the Ligurian Sea) to vessel traffic, including whale-watching vessels, be carefully monitored. The study monitored 25 fin whales in their feeding ground during approaches by the inflatable boat within 5 to 10 m, moving with sudden speed (0 to 26 km/h) and directional changes for an hour. Whales were also monitored before and after the sudden approach from distances >200 m and at low speeds (5 km/h). Fin whales responded to the close approach of the boat by apparently ceasing feeding, beginning to travel at increased speed, and reducing the amount of time spent on the surface. One hour after close approach, the fin whales had not resumed to pre-disturbance behaviours. The authors note fin whale response may be, entirely or in part, a response to biopsy sampling, which was occurring as part of the same study. No source or received sound levels from the inflatable boat were provided.

Minke whale response to a research vessel was examined based on census data collected during line transect surveys for marine mammals (Palka and Hammond 2001). Typical avoidance distances were 717 m, 563 m, and 695 m in the Gulf of Maine, North Sea and Northeastern Atlantic, respectively, and corresponding RLs were estimated at 110 to 120 dB re 1 µPa. The average sighting distance of blue whales observed off the south coast of Newfoundland from a seismic vessel that was not operating airguns was 1,227 m (based on 12 sightings; Moulton and Holst 2010). Blue (and fin) whales were noted to remain feeding in a region exposed to Low-Frequency Active (LFA) sonar where RLs often exceeded 140 dB re 1 µPa (Croll et al. 2001).

Marine mammal monitoring was undertaken from a high-speed, catamaran car ferry transiting the Bay of Fundy during the summers of 1998 to 2002 (Dufault and Davis 2003). The ferry had no propellers but used four water jets for power and travelled at speeds of 40 knots. The majority of Baleen Whales (including fin, humpback and minke whales) sighted from the ferry appeared to exhibit avoidance behaviour including heading away, changing heading, or diving (Dufault and Davis 2003). Avoidance responses were greater for humpback whales than for the other species of Baleen Whales that were observed.

There have been limited studies of Baleen Whale behaviour near vessels operating dynamic positioning thrusters. Data from a 2006 to 2007 Controlled Source Electromagnetic survey in the Orphan Basin (Abgrall et al. 2008), off north-east Newfoundland indicated that Baleen Whale sighting rates during periods when dynamic positioning thrusters were active on the survey site were lower than those during periods when dynamic positioning thrusters were not active (0.02 sightings/h vs. 0.09 sightings/h, respectively). However, the authors of this study note that these results should be interpreted with caution as the data recording protocols were not designed to isolate the effect of dynamic positioning thrusters.

Although not directly comparable to horizontal directional drilling operations that are expected to occur during the Project, there has been some study of Baleen Whale response to drilling noise from rigs and platforms. Migrating gray whales generally exhibited avoidance when RLs exceeded 120 dB re 1 µPa (Malme et al. 1984, 1983) and bowhead whales generally did not respond to drilling sounds in the 100 to 130 dB re 1 µPa range (Richardson et al. 1990).

Overall, Baleen Whales often exhibit slow and inconspicuous avoidance manoeuvres when vessels approach slowly and non-aggressively. In response to strong or rapidly changing vessel noise, Baleen Whales often interrupt their normal behaviour and swim rapidly away; this is especially pronounced when a boat heads directly towards a whale. Based on their review of studies with known RLs, Southall et al. (2007) noted that Baleen Whales generally exhibit no or very limited response to RLs from continuous sound sources (including vessels and drilling rigs) of 90 to 120 dB re 1 µPa and that there was an increasing probability of avoidance and other behavioural effects in the 120 to 160 dB re 1 µPa range. Studies indicate that there is considerable variability in Baleen Whale response to vessels.

Acoustic masking from anthropogenic sound sources like vessels is recognized as a potential threat to Baleen Whales (Clark et al. 2010). Ships produce sounds that are primarily low-frequency and which overlap with the frequencies produced and presumably perceived by Baleen Whales. For some Baleen Whale species, sounds are known to be communication signals (Clark 1983; Tyack 1981). It is uncertain if Baleen Whales use low-frequency sounds for orientation, navigation, or detection of prey and predators such as odontocetes use high-frequency sounds (Croll et al. 2001). Animals can adapt their behaviour to minimize masking, and it has been assumed that such behavioural changes indicate that masking has occurred (National Research Council (NRC) 2003). There have been few studies that have investigated masking in Baleen Whales. Gray whales changed the timing of their vocalizations, increased the amplitude of the vocalizations, and used more frequency-modulated signals in noisy environments (Dahlheim 1987). Humpback whales exposed to low frequency active sonar increased the duration of their songs by 29% (Miller et al. 2000).

Acoustic Modelling and Assessment of Effects

It is possible that Baleen Whales may avoid vessels associated with construction activities. The dominant frequencies for transiting vessels (40 to 80 Hz) and vessels operating dynamic positioning thrusters (400 to 800 Hz; Jasco 2011a) overlap with the presumed hearing range of Baleen Whales. Based on acoustic modelling, and assuming that Baleen Whales exhibit avoidance of Project vessels at RLs of 120 to 140 dB re 1 µPa (rms), Baleen Whales may avoid cable laying and rock placement vessels at distances ranging from tens of metres to 11.6 km. Avoidance is predicted to extend the farthest (RLs of 120 dB re 1 µPa (rms) at 11.6 km) for a rock placement vessel operating dynamic positioning thrusters within the submarine cable crossing corridor. The same vessel in transit mode is estimated to produce sound levels of 120 dB at distances up to 4.9 km. Avoidance exhibited by Baleen Whales at these distances would not seriously affect migration and / or feeding activities. Humpback whales, and to a lesser extent minke whales, occur in relatively high densities in and near the Corridor LSA. During migration, humpback and other Baleen Whales would be expected to detour around Project vessels and any disruption to feeding is expected to be localized and temporary.

The potential effect of auditory masking for Baleen Whales is increased by the large amount of overlap between the predominant frequencies produced by vessel noise (<1 kHz) and the frequencies at which Baleen Whales call and presumably hear. Within the Corridor LSA, the potential for masking would be highest as a vessel(s) passed by Baleen Whales, which likely will occur over a limited time period. No specific areas of Baleen Whale concentration have been identified along the Corridor LSA, but humpback whales occur in relatively high numbers from L'Anse au Loup to L'Anse au Clair. It is possible that humpback whales and other Baleen Whales that occur in the vicinity of the Project, when construction is occurring, may experience masking. The potential for masking is diminished because Baleen Whales typically exhibit at least localized avoidance of ships where sound levels would be highest.

Jasco (2011a) estimated that HDD of the conduits would produce sounds with very low dominant frequencies of 1.3 to 1.6 Hz, below the frequency of presumed best hearing for Baleen Whales. When M-weighting for baleen whales is applied, the range to 120 dB re 1 µPa (rms) for drilling operations decreases from a maximum of 3,150 m to 315 m. The corresponding range to 140 dB considering M-weighting is less than 5 m (Jasco 2011a). As such, drilling operations are expected to have negligible effects on Baleen Whales.

Construction at the L'Anse au Diable and Dowden's Point electrode sites, including the breakwater berms, will not involve vessel traffic. However, sound may be introduced into adjacent marine waters by on-land construction of the breakwater berms. Baleen Whales which occur near the sites may be exposed to underwater sounds from these activities but behavioural effects are expected to be temporary and localized if any.

Hearing Impairment

As noted in Table 14.3.3-2, there is potential (albeit limited) for Project vessels, particularly those operating dynamic positioning thrusters, to cause hearing impairment in Baleen Whales (and indeed other Marine Mammals and Sea Turtles). To aid the reader, an overview of the types of hearing impairment and corresponding sound levels thought to elicit hearing impairment are provided below.

Overview of Hearing Impairment

Temporary Threshold Shift (TTS), is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger to be heard. It is a temporary phenomenon, and (especially when mild) is not considered to represent physical damage or "injury" (Southall et al. 2007). Rather, the onset of TTS is an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility.

The magnitude of TTS depends on the level and duration of noise exposure, and to some degree on frequency, among other considerations (Southall et al. 2007; Richardson et al. 1995; Kryter 1985). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. In terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. Only a few data have been obtained on sound levels and durations necessary to elicit mild TTS in marine mammals (none in mysticetes; Southall et al. 2007).

When Permanent Threshold Shift (PTS) (i.e., permanent hearing loss) occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter 1985). Physical damage to a mammal's hearing apparatus can occur if it is exposed to sound impulses that have very high peak pressures, especially if they have very short rise times (time required for sound pulse increase from the baseline peak to peak).

In recent years, a panel of (mainly United States or US) experts in acoustic research from behavioural, physiological, and physical disciplines has worked to produce scientific recommendations for updated marine mammal noise exposure criteria (Southall et al. 2007). For various marine mammal groups and sound types (single pulse, multiple pulses, nonpulse or continuous), Southall et al. (2007) proposed levels above which there is a scientific basis for expecting that noise exposure would cause injury to occur. These new exposure criteria incorporate frequency-weighting functions (M-weighting) for assessing the effects of sound on marine mammals, which accounts for the major differences in auditory capabilities across marine mammal groups and species. M-weighting refers to frequency-dependent weighting in accordance with the sensitivity of the marine mammal ear to different frequencies (Southall et al. 2007). Minimum exposure criteria for injury are defined as the energy level at which single exposure to sound is estimated to cause onset of PTS. Temporary Threshold Shift was not considered an injury (Southall et al. 2007).

Underwater sounds produced by Project activities will be those primarily associated with ships and to a limited extent drilling of the subsea boreholes. These sound types are considered nonpulse or continuous. In their review, Southall et al. (2007) estimated that received levels would need to exceed the TTS threshold by at least 20 dB, on a SEL basis, for there to be risk of PTS from a nonpulse sound source. Thus, for cetaceans exposed to a nonpulse sound, they estimate that the PTS threshold might be an M-weighted SEL of approximately 215 dB re 1 $\mu Pa^2 \cdot s$. The corresponding PTS threshold for Pinnipeds is 203 dB re 1 $\mu Pa^2 \cdot s$. On a SPL basis, Southall et al. (2007) estimate that the PTS threshold might be 230 dB re 1 µPa (peak) and 218 dB re 1 µPa (peak) for cetaceans and Pinnipeds, respectively. These SPL estimates equate to peak pressures known or assumed to elicit TTS plus 6 dB. There are no data on the nonpulse sound levels that may cause hearing impairment in Sea Turtles.

There are many factors thought to determine the onset and extent of PTS, including the duration an animal is exposed to a sound. Ketten (1994) has noted that the criteria for differentiating the sound pressure levels that result in PTS (or TTS) are location and species-specific. PTS effects may also be influenced strongly by the health of the receiver's ear.

Acoustic Modelling and Assessment of Effects

As noted above, there are no studies that have directly examined hearing impairment in Baleen Whales. For the purposes of this assessment, sound levels expected to cause temporary hearing impairment (TTS) were examined. For continuous sound sources like shipping, the best available estimate for TTS is that of Southall et al. (2007), which is 195 dB re 1 µPa^2 s for non-impulse or continuous sound. This estimate cannot be translated to a SPL without allowance for duration of exposure, i.e., 195 dB re 1 uPa for 1 s; 185 dB re 1 uPa for 10 s, 175 dB re 1 uPa for 100 s. Extrapolation to times longer than 100 s, though necessary to deal with noise from a ship transit, is not advisable (Richardson 2010, pers. comm.). Corresponding estimates for PTS are assumed to be 20 dB higher.

Based on the acoustic modelling, sound levels from the horizontal directional drilling for the subsea conduits are well below those expected to elicit TTS at both Forteau Point and Shoal Cove (see Table 3.1 to Table 3.4 in Jasco 2011a). Similarly, estimated sound levels from vessels in transit and those using dynamic positioning thrusters are also well below those thought to elicit TTS at all four modelling locations along the Strait of Belle Isle submarine cable crossing corridor (see Table 3.5 to Table 3.20 in Jasco 2011a). Based on this information, the potential that Baleen Whales would experience hearing impairment (either TTS or PTS) from Project activities is negligible.

Collisions with Vessels

Another concern with vessel traffic is the potential for striking marine mammals. There is evidence suggesting that a greater rate of mortality and serious injury correlates with a greater vessel speed at the time of a ship strike (Vanderlaan and Taggart 2007; Laist et al. 2001). Most lethal and severe injuries to large whales resulting from documented ship strikes have occurred when vessels were travelling at 14 knots or greater (Laist et al. 2001), speeds not uncommon among large ships and not limited to high-speed vessels. Vanderlaan and Taggart (2007), using a logistic regression modelling approach based on vessel strike records, found that for vessel speeds greater than 15 knots, the probability of a lethal injury (mortality or severe injury) due to a ship strike approaches one. In a review of 58 large whale - ship strikes in which the vessel speed was known, the average speed of vessels involved in ship strikes that resulted in mortality or serious injuries to the whale was found to be 18.6 knots (Jensen and Silber 2003).

Laist et al. (2001) reported that fin whales are struck most frequently, but that right, humpback, sperm, and gray whales also are regularly hit. There are less frequent records of collisions with blue, sei, and minke whales (Laist et al. 2001). Van Waerebeek et al. (2006) compiled ship strike records for large whales in the Southern Hemisphere. The large whales included right, blue, pygmy blue, sei, fin, Bryde’s, and humpback whales. It is likely that many ship strikes go undetected or unreported as the strikes may occur in remote areas or struck whales may not strand on land (Jensen and Silber 2003).

Project vessels within the Corridor LSA Component are expected to travel at very slow speeds and in a constant direction when installing the submarine cable (vessel speed up to 0.4 knots) and associated rock berm (vessel speed up to 2 knots). Vessels are expected to transit to and from the construction site at maximum speeds of 10 to 12 knots. Based on available information, there is limited chance that Baleen Whales would experience mortality or serious injury from collisions with Project vessels. In addition, ship’s crews will keep a watch for Baleen Whales and alter the vessel course to avoid whales if possible. With mitigation measures in place, no mortality is expected and no residual effects related to collisions with vessels are predicted to occur.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Baleen Whales are predicted as:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations;
- Low to moderate magnitude because the number of affected Baleen Whales is likely to represent a small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Baleen Whales;
- Limited to the RSA;

- Short-term duration because effects are limited to the Construction period (June to November in Year 1 of a four-year construction phase) and will not occur after vessels have left the area; and
- Low in frequency as the installation of the subsea cable and placement of rock berms will occur only once during the Construction phase.

There is a moderate to high degree of confidence that the level of likely residual effect on Baleen Whales will not be greater than predicted. Acoustic modelling conducted specifically for the Project's construction activities and a relatively good understanding of Baleen Whale response to vessel traffic support this level of confidence. There is some uncertainty about masking given that this has not directly been studied in Baleen Whales. Uncertainties are addressed in the EIS through conservative estimates and assumptions, and through adaptive management.

14.3.5.4 Construction Effects: Toothed Whales

Behavioural Responses to Vessel Traffic and Drilling

Similar to the other KIs, background information on Toothed Whales (also referred to as odontocetes) hearing is provided below, followed by a review of the literature, and the effects assessment.

Background Information on Toothed Whale Hearing

The small to moderate-sized Toothed Whales whose hearing has been studied have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at, and above, several kHz. Most of the odontocete species have been classified as having functional hearing from about 150 Hz to 160 kHz (Southall et al. 2007). There are few data on the absolute hearing thresholds of most of the larger, deep-diving Toothed Whales, such as the sperm and beaked whales. However, Cook et al. (2006) report that a stranded Gervais' beaked whale showed evoked potentials from 5 to 80 kHz, with best sensitivity at 80 kHz. In another study, Finneran et al. (2009) found that an adult Gervais' beaked whale had a similar upper cutoff of 80 to 90 kHz. Porpoises have higher functional hearing from about 200 Hz to 180 kHz (Southall et al. 2007).

Review of Toothed Whale Behavioural Responses to Vessel Traffic and Drilling

There have been several studies of Toothed Whale response to vessel traffic. Richardson et al. (1995) provide a thorough review of studies up to 1995 and Southall et al. (2007) provides a more recent review that focuses on studies where RLs were measured or estimated. Overall, many Toothed Whales show considerable tolerance of vessel traffic, although they sometimes react at long distances if confined by ice or shallow water, or if previously harassed by vessels. The following text focuses on reviews of studies of Toothed Whale species found in the RSA. There are no data available for Toothed Whale response to HDD activities.

Reports of sperm whales' reactions to boat noises vary, with most studies showing little evidence of disturbance. Sperm whales monitored visually and acoustically off New Zealand showed subtle behavioural responses to vessels (whale-watching boats within 450 m; Gordon et al. 1992). Sperm whales spent less time on the surface, respired less frequently, and took longer to start clicking at the start of a dive when boats were nearby compared to if they were absent. These subtle changes in behaviour occurred at a RL of about 104 dB re 1 µPa. Resident sperm whales that are repeatedly exposed to small vessels show subtle changes in various measures of behaviour, and transient individuals (which presumably had less exposure to vessels) reacted more strongly (Richter et al. 2006, 2003).

Sperm whales often can be approached with small motorized or sailing vessels (Papastavrou et al. 1989), but were noted to avoid outboard-powered whale-watching vessels up to 2 km away (Cawthorn 1992). Würsig et al. (1998) reported that sperm whale reactions to a survey vessel (1992 to 1994 GulfCet surveys) tended to be "non-existent" unless the vessel approached the animals within several hundred metres. Of the 15 sightings of sperm whales during which responses were recorded, on 11 occasions the sperm whales were reported to have exhibited no reaction. During the other four encounters, the sperm whales dove abruptly. All four of those occurred within 200 m of the ship. Sperm whales were never reported to approach the survey vessel. The authors of that report estimated the sound levels of their survey vessels in the 20 to 1,000 Hz frequency range to be in the order of 120 to 150 dB re 1 µPa at 200 m and 105 to 125 dB re 1 µPa at 9 to 10 km. Sperm whales off the Azores were studied using both land- and boat-based observations to assess the effects of whale watching boats on those animals, without any clear evidence of disturbance (Magalhães et al. 2002).

There have been occasional reports of adult male sperm whales ramming ships; such an encounter was recorded in the Marianas in 2007 by the Mariana Islands Sea Turtle Cetacean Survey. The survey vessel encountered a group of surface active sperm whales and was directly approached by two male sperm whales; the lead animal rammed the ship before both swam beneath the ship and re-joined the other whales (Fulling et al. 2009). A number of theories for this behaviour were suggested and included the whales viewing the ship as a competitor, and perceiving the ship as a threat as sperm whales were directly targeted for harvest in the Mariana region as late as the 1970s (Fulling et al. 2009).

There are little systematic data on the behavioural reactions of beaked whales to vessel noise. Most beaked whales tend to avoid approaching vessels (Würsig et al. 1998). They may also dive for an extended period when approached by a vessel (Kasuya 1986). Aguilar-Soto et al. (2006) suggest that foraging efficiency of Cuvier's beaked whales may be reduced by close approach of a vessel based on dive and acoustic data received from one whale; the authors caution that no conclusions can be drawn based on their single observation.

Dolphins of many species tolerate or even approach vessels. Some dolphin species approach moving vessels to ride the bow or stern waves (Williams et al. 1992). In western Australia, bottlenose dolphin behaviour became more erratic and dolphin schools tightened in response to controlled boat interactions (Bejder et al. 2006). During vessel interactions with bottlenose dolphins in New Zealand, travelling behaviour increased and resting behaviour decreased (Lusseau 2004, 2003). Also, dolphins apparently avoided areas and times characterized by high vessel traffic (Lusseau 2005). Common dolphins in New Zealand have also reacted to boats with changes in their overall behavioural budget, including decreases in foraging and resting times and increases in socializing and milling behaviour (Stockin et al. 2008). Atlantic white-sided dolphin and white-beaked dolphin response to research vessels were examined based on census data collected during line transect surveys for marine mammals (Palka and Hammond 2001). Typical avoidance distances were 592 m and 716 m for white-sided and white-beaked dolphins, respectively. White-beaked dolphins actually approached the research vessel when it was 150 to 300 m away.

Killer whales have also been shown to increase travelling and decrease foraging behaviour because of the presence of nearby vessels (Williams et al. 2002a, b). Vessel impact studies of southern resident killer whales also showed decreased foraging in the presence of boats (Lusseau et al. 2009) and other behavioural responses (e.g., Noren et al. 2009), indicating that vessel disturbance may have long-term consequences.

In contrast to most Toothed Whales, harbour porpoises are sensitive to a wide range of anthropogenic sounds, including those from vessels, at low exposure RLs (approximately 90 to 120 dB re 1 uPa; Southall et al. 2007). Harbour porpoises tend to avoid boats (Richardson et al. 1995) and all recorded exposures exceeding 140 dB induced obvious and sustained avoidance behaviour in harbour porpoises (Southall et al. 2007).

Based on their review of studies with known received sound levels, Southall et al. (2007) noted that Toothed Whales generally exhibit variable responses to sound and they were not able to derive a clear conclusion on SELs that might lead to avoidance.

It is generally thought that Toothed Whales are less likely than Baleen Whales to experience masking from vessel noise because they use much higher frequencies for communication and echolocation than the predominant low-frequency noise from vessels. Toothed Whales have adapted their behaviour to presumably minimize the effects of masking. Beluga whales increased call repetition and shifted to higher peak frequencies in response to boat traffic (Lesage et al. 1999). Similarly, Au et al. (1985) found that a beluga increased both the average level and frequency of its vocalizations, in what appeared to be an attempt to avoid masking effects of increased low-frequency noise.

Although some Toothed Whales appear to adapt their vocal behaviour to reduce the effects of masking this does not imply that there were no negative effects from increased levels of noise; masking may have been minimized but not eliminated (NRC 2003).

Acoustic Modelling and Assessment of Effects

Like Baleen Whales, it is possible that Toothed Whales may avoid vessels associated with construction activities. The dominant frequencies for transiting vessels (40 to 80 Hz) and vessels operating dynamic positioning thrusters (400 to 800 Hz; Jasco 2011a) overlap with the hearing range of most Toothed Whales. However, the small to moderate-sized Toothed Whales whose hearing has been studied have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at, and above, several kHz. Based on acoustic modelling and the application of M-weighting, and assuming that Toothed Whales exhibit avoidance of Project vessels at RLs of 120 to 140 dB re 1 µPa (rms), Toothed Whales may avoid cable laying and rock placement vessels at distances ranging from tens of metres to 11.6 km. Avoidance is predicted to extend the farthest (RLs of 120 dB re 1 µPa (rms) at 11.6 km) for a rock placement vessel operating dynamic positioning thrusters within the submarine cable crossing corridor. If Toothed Whales exhibit avoidance of the same vessel in transit, avoidance may occur at distances up to 2.2 km (corresponding to an M-weighted estimate of 120 dB). Avoidance exhibited by Toothed Whales at these distances would not seriously affect migration and / or feeding activities.

The potential effect of auditory masking for Toothed Whales is limited by the small amount of overlap between the predominant frequencies produced by ship noise and construction activities (<1 kHz) and the frequencies at which Toothed Whales call and hear. However, some Toothed Whales that occur within the vicinity of the Project, when construction is occurring, may experience masking. If masking does occur, some Toothed Whales may change their call types and frequencies during noise exposure in order to overcome the masking (Lesage et al. 1999; Au et al. 1985). Also, no specific areas of Toothed Whale concentration have been identified within the RSA.

Jasco (2011a) estimated that HDD for the conduits produced sounds with very low dominant frequencies of 1.3 to 1.6 Hz. It is unlikely that Toothed Whales would be able to hear HDD within the water column (Jasco 2011a). As such, drilling operations are expected to have negligible effects on Toothed Whales.

Construction at the L'Anse au Diable and Dowden's Point electrode sites, including the breakwater berms, will not involve vessel traffic. However, sound may be introduced into adjacent marine waters by on-land construction of the breakwater berms. Toothed Whales which occur near the sites may be exposed to underwater sounds from these activities but behavioural effects are expected to be temporary and localized.

Hearing Impairment

Sound exposures that elicit hearing impairment in Toothed Whales have been measured for two species, beluga and bottlenose dolphin (Southall et al. 2007). For the purposes of this assessment, sound levels expected to cause temporary hearing impairment (TTS) were examined. For continuous sound sources like drilling and shipping, the best available estimate is that of Southall et al. (2007) for mid- and high-frequency odontocetes, which is 195 dB re 1 $\mu Pa^2 \cdot s$. This estimate cannot be translated to a SPL without allowance for duration of exposure, i.e., 195 dB re 1 uPa for 1 s; 185 dB re 1 uPa for 10 s, 175 dB re 1 uPa for 100 s. Extrapolation to times longer than 100 s, though necessary to deal with noise from a ship transit, is not advisable (Richardson 2010, pers. comm.). Corresponding estimates for PTS are assumed to be 20 dB higher.

Based on the acoustic modelling, sound levels from drilling of the subsea conduit are well below those expected to elicit TTS at both Forteau Point and Shoal Cove (see Table 3.1 to Table 3.4 in Jasco 2011a). Drilling may not even be detectable to Toothed Whales given the very low dominant frequencies (1.3 to 1.6 Hz). Estimated sound levels from vessels in transit and those using dynamic positioning thrusters are also well below those thought to elicit TTS at all four modelling locations along the Strait of Belle Isle submarine cable crossing corridor (see Table 3.5 to Table 3.20 in Jasco 2011a). Based on this information, the potential that Toothed Whales would experience hearing impairment (either TTS or PTS) from Project activities is negligible.

Collisions with Vessels

Toothed Whales are at risk from vessel collision. Van Waerebeek et al. (2006) documented ship strikes for 19 species of small Toothed Whales, and sperm whales have also been killed by vessel collisions (Laist et al. 2001). However, given the increased manoeuvrability of small Toothed Whales they are generally considered at lower risk of collision than large Baleen Whales.

Project vessels within the Corridor LSA Component will travel at very slow speeds and in a constant direction when installing the submarine cable (vessel speed up to 0.4 knots) and construction of the associated rock berm (vessel speed up to 2 knots). Vessels are likely to transit to and from the construction site at maximum speeds of 10 to 12 knots. Based on available information, it is unlikely that Toothed Whales would experience mortality or serious injury from collisions with Project vessels. Most Toothed Whales are small relative to vessels and are capable of high swim speeds, which enable them to avoid collisions. Also, it is likely that Toothed Whales would avoid vessels underway, maintaining distances that would prevent ship strikes. In addition, ship's crews will keep a watch for Toothed Whales and alter the vessel course to avoid whales if possible. With mitigation measures in place, no mortality or injury is predicted and no residual effects resulting from collisions with vessels are likely to occur.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Toothed Whales are predicted as:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations;
- Low to moderate magnitude because the number of affected Toothed Whales is likely to represent a small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Toothed Whales;
- Limited to the RSA;
- Short-term duration because effects are limited to the construction period (June to November in Year 1 of a four-year construction phase) and will not occur after vessels have left the area; and
- Low in frequency because the installation of the subsea cable and placement of rock berms will occur only once during the construction phase.

There is a high degree of confidence that the level of likely residual effect on Toothed Whales will not be greater than predicted because previous studies on response to vessel traffic and hearing impairment, as well as acoustic modelling conducted specifically for the Project's construction activities support this level of confidence.

14.3.5.5 Construction Effects: Pinnipeds

Behavioural Responses to Vessel Traffic and Drilling

Similar to the other KIs, background information on Pinniped hearing is provided below, followed by a review of the literature, and the effects assessment.

Background Information on Pinniped Hearing

Underwater audiograms have been obtained using behavioural methods for three species of phocid seals, two species of monachid seals, two species of otariids, and the walrus (Kastelein et al. 2009, 2002; Kastak and Schusterman 1999, 1998; Richardson et al. 1995). The functional hearing range for Pinnipeds in water is considered to extend from 75 Hz to 75 kHz (Southall et al. 2007). Compared to odontocetes, Pinnipeds tend to have lower best frequencies, lower high-frequency cutoffs, better auditory sensitivity at low frequencies, and poorer sensitivity at the best frequency.

At least some of the phocid seals have better sensitivity at low frequencies (≤1 kHz) than do odontocetes. Below 30 to 50 kHz, the hearing thresholds of most species tested are essentially flat down to about 1 kHz, and range between 60 and 85 dB re 1 µPa. Measurements for harbour seals indicate that, below 1 kHz, their thresholds under quiet background conditions deteriorate gradually to approximately 75 dB re 1 µPa at 125 Hz (Kastelein et al. 2009).

Review of Pinniped Behavioural Responses to Vessel Traffic and Drilling

Relative to cetaceans, there have been few studies of seal response to vessels. When in the water (as compared to hauled out), seals appear less responsive to approaching vessels. Some seals will approach a vessel out of apparent curiosity, including noisy vessels such as those operating airgun arrays (Moulton and Lawson 2002). Suryan and Harvey (1999) reported that Pacific harbour seals (*Phoca vitulina richardsi*) commonly left the shore when powerboat operators approached to observe them. These seals apparently detected a powerboat at a mean distance of 264 m, and seals left their haul-out sites when boats approached to within 144 m. Harbour seals did not exhibit any behavioural response to Acoustic Harassment Devices deployed around aquaculture sites; estimated exposure RLs were 120 to 130 dB re 1 µPa. Southall et al. (2007) noted that available information suggest that Pinnipeds in water do not exhibit strong behavioural responses to continuous or nonpulse sound at RLs between approximately 90 to 140 dB re 1 µPa.

Many Pinnipeds use low-frequency sound for communications underwater (Watkins and Wartzok 1985). Passive listening to other natural sounds may also be important in localization of prey or predators, or in spatial orientation and navigation (Schusterman et al. 2000). There have been several studies of masking in Pinnipeds, more specifically for harp seals (Terhune and Ronald 1971), ringed seal (Terhune and Ronald 1975), harbour seal (Southall et al. 2000; Terhune 1991; Turnbull and Terhune 1990), northern fur seal (Moore and Schusterman 1987), northern elephant seal (Southall et al. 2000), and California sea lion (Southall et al. 2000). In general, Pinnipeds hear signals well in noise but researchers note that caution is warranted when considering the effects of underwater noise and masking.

Acoustic Modelling and Assessment of Effects

Some seals may avoid vessels associated with construction activities while other seals may be curious and approach the vessels. The dominant frequencies for transiting vessels (40 to 80 Hz) and vessels operating dynamic positioning thrusters (400 to 800 Hz; Jasco 2011a) overlap with the hearing range of Pinnipeds. Based on acoustic modelling and the application of M-weighting, and assuming that seals exhibit avoidance of Project vessels at RLs of 140 dB re 1 µPa (rms), seals may avoid cable laying and rock placement vessels at distances ranging from tens of metres to 1.3 km. Avoidance is predicted to extend the farthest (RLs of 140 dB re 1 µPa (rms) at 1.3 km) for a rock placement vessel operating dynamic positioning thrusters within the submarine cable crossing corridor. If seals exhibit avoidance of the same vessel in transit, avoidance may occur at distances up to 125 m (corresponding to an M-weighted estimate of 140 dB). Avoidance exhibited by seals at these distances would have a negligible effect on migration and / or feeding activities.

Masking during continuous shipping sounds is unlikely to be important because most sounds important to seals are predominantly at higher frequencies than shipping noise. However, masking of some environmental sounds may occur when Project vessels occur close to seals.

Jasco (2011a) estimated that HDD of the conduits produced sounds with very low dominant frequencies of 1.3 to 1.6 Hz. Seals probably cannot hear HDD within the water column (Jasco 2011a). As such, drilling operations are expected to have negligible effects on seals.

Construction at the L'Anse au Diable and Dowden's Point electrode sites, including the breakwater berms, will not involve any vessel traffic. However, sound may be introduced into adjacent marine waters by on-land construction of the breakwater berms. Few seals are expected near these sites, particularly at the Dowden's

Point site. If seals do occur near the sites, they may be exposed to underwater sounds from these activities but behavioural effects are expected to be temporary and localized. Similarly, if seals haul-out near the L'Anse au Diable and Dowden's Point shoreline sites, they may avoid the area during construction; seals are not known to use the L'Anse au Diable and Dowden's Point sites for haul out.

Hearing Impairment

Sound exposures that elicit hearing impairment in Pinnipeds have been measured for three species, harbour seal, California sea lion, and northern elephant seal (see Southall et al. 2007). For the purposes of this assessment, sound levels expected to cause temporary hearing impairment (TTS) were examined. For continuous sound sources like drilling and shipping, the best available estimate is that of Southall et al. (2007) for Pinnipeds in water, which is 183 dB re 1 $\mu Pa^2 \cdot s$. This estimate cannot be translated to a SPL without allowance for duration of exposure, i.e., 183 dB re 1 uPa for 1 s; 173 dB re 1 uPa for 10 s, 163 dB re 1 uPa for 100 s. Extrapolation to times longer than 100 s, though necessary to deal with noise from a ship transit, is not advisable (Richardson 2010, pers. comm.). Corresponding estimates for PTS are assumed to be 20 dB higher.

Based on the acoustic modelling, sound levels from drilling of the subsea conduits are below those expected to elicit TTS at both Forteau Point and Shoal Cove (see Table 3.1 to Table 3.4 in Jasco 2011a). In addition, it is unlikely that seals would occur close to the HDD sites given the target water depths for this activity (approximately 80 m) and drilling may not even be detectable to Pinnipeds given the very low dominant frequencies (1.3 to 1.6 Hz). Based on the best available information, it is unlikely that Pinnipeds would experience temporary hearing impairment (TTS) and it is also unlikely that they would incur PTS from Project drilling activities.

Estimated sound levels from vessels in transit and those using dynamic positioning thrusters during the construction phase are higher than sound levels during drilling. If a seal occurs within 5 to 10 m of the cable laying or rock dumping vessel during transit (see Table 3.5 to Table 3.12 in Jasco 2011a), it is possible that the seal could incur TTS. This distance increases to 20 to 25 m (see Table 3.13 to Table 3.20 in Jasco 2011a) if the dynamic positioning thrusters are operating. As noted above, seals typically exhibit avoidance of vessels, so it is unlikely they would occur close enough to, and for a sufficient duration, to incur TTS. Seals are not likely to be exposed to sound levels from vessels thought high enough to cause PTS. Therefore, effects to seals' hearing are likely to be negligible.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Pinnipeds are as follows:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations;
- Low to moderate magnitude because the number of affected Pinnipeds is likely to represent a very small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Pinnipeds;
- Limited to the RSA;
- Short-term duration because effects are limited to the construction period (June to November in Year 1 of a four-year construction phase) and will not occur after vessels have left the area; and
- Low in frequency because the installation of the subsea cable and construction of rock berms will occur only once during the construction phase.

There is a high degree of confidence that the level of residual effect on Pinnipeds will not be greater than predicted because previous studies on response to vessel traffic and hearing impairment, in addition to the Project-specific acoustic modelling, support this level of confidence.

14.3.5.6 Construction Effects: Sea Turtles

Behavioural Responses to Vessel Traffic and Drilling

As with the other KIs, background information on Sea Turtle hearing is provided below, followed by a review of the literature, and the effects assessment.

Background Information on Sea Turtle Hearing

Little is known about the role of sound perception in the Sea Turtle's normal activities but studies show that they can detect and respond to underwater sound. Although there have been a limited number of studies on Sea Turtle hearing (see review by Southwood et al. 2008), the available data are not comprehensive. However, these data demonstrate that Sea Turtles appear to be low-frequency specialists. The frequency range of best hearing sensitivity of Sea Turtles extends from approximately 200 to 700 Hz. Sensitivity deteriorates as one moves away from this range to either lower or higher frequencies. However, there is some sensitivity to frequencies as low as 60 Hz, and probably as low as 30 Hz (Ridgway et al. 1969). Thus, there is substantial overlap in the frequencies that Sea Turtles detect relative to the dominant frequencies in ship noise.

Review of Sea Turtle Behavioural Responses to Vessel Traffic

Relative to marine mammals, there have been far fewer studies of the effects of vessel noise (or indeed any type of noise) on Sea Turtles. A recent study found that green sea turtles often responded behaviourally to close, oncoming small vessels and that the nature of the response was related to vessel speed, with fewer turtles displaying a flee response as vessel speed increased (Hazel et al. 2007). The vessel used in this study was a 6 m long aluminum boat powered by a 40 hp outboard motor. Turtles were observed to flee from the boat when it travelled at slow speeds (approximately 4 km/hr) in 60% of observations (Hazel et al. 2007). Hazel et al. (2007) suggested that a turtle's ability to detect an approaching vessel was vision-dependent. No information concerning masking of hearing in Sea Turtles was found during the literature review.

Acoustic Modelling and Assessment of Effects

Few, if any Sea Turtles are expected to occur in the Strait of Belle Isle RSA Component where most construction will occur. Loggerhead sea turtles have not been sighted there and there have been relatively few sightings of leatherback sea turtles (see Section 10.6.8). If Sea Turtles did occur within the proposed Strait of Belle Isle submarine cable crossing corridor during construction, it is likely that they would avoid at least the immediate area around vessels. Any disruptions of Sea Turtle movements and feeding in the Strait of Belle Isle RSA Component are expected to be temporary.

Jasco (2011a) estimated that HDD of the conduits produced sounds with very low dominant frequencies of 1.3 to 1.6 Hz. It is unlikely that Sea Turtles can hear HDD within the water column. This, coupled with the unlikely occurrence of Sea Turtles near the HDD, results in the prediction that drilling operations are expected to have negligible effects on Sea Turtles.

Construction at the L'Anse au Diable and Dowden's Point electrode sites, including the breakwater berms, will not involve any vessel traffic. However, sound may be introduced into adjacent marine waters by on-land construction of the breakwater berms. Few Sea Turtles are expected near these sites, particularly at the L'Anse au Diable site. If Sea Turtles do occur near the sites, they may be exposed to underwater sounds from these activities but behavioural effects are expected to be minimal.

Hearing Impairment

There have been no studies of hearing impairment in Sea Turtles relative to continuous sounds like those from shipping. Lenhardt (2002) and Moein et al. (1994) reported TTS for loggerhead turtles exposed to impulse sounds from airguns. However, they did not report the RLs that led to TTS.

There are no data to indicate whether exposure to vessel or drilling noise at close range could cause hearing impairment in Sea Turtles. Hearing impairment (whether temporary or permanent) from vessel sounds is considered unlikely because turtles are unlikely to occur close to the sound source, as individuals are mobile and the vessel travels relatively quickly compared to the swimming speed of a sea turtle. At short distances from the source, received sound level diminishes rapidly with increasing distance. In that situation, even a small-scale avoidance response could result in a substantial reduction in sound exposure. Few Sea Turtles are expected to occur in the Strait of Belle Isle LSA and there is evidence that Sea Turtles do show movement away from sound sources. Considering all of these factors, it is unlikely that construction activities would cause hearing impairment in Sea Turtles.

Collisions with Vessels

The US National Marine Fisheries Service has recognized that Sea Turtles are highly susceptible to vessel collisions because they regularly surface to breathe and often rest at or near the surface. Of all dead sea turtle strandings recorded from Queensland, Australia, 14% were attributable to ship strikes (Hazel and Gyuris 2006). A study carried out to assess the ability of green turtles to avoid vessels in Morton Bay, Queensland, found that the proportion of turtles that displayed a flee response to approaching vessels decreased as speed increased, and that this was most notable for close encounters (Hazel et al. 2007). Turtles were observed to flee from slow moving vessels (approximately 4 km/hr) in 60% of observations (Hazel et al. 2007). This study also indicated that a turtle’s ability to detect an approaching vessel was vision-dependent and so directly related to water clarity. The study proposed that the vision-dependence of Sea Turtles explains their inability to evade fast vessels (Hazel et al. 2007).

Few Sea Turtles are expected to occur within the Strait of Belle Isle submarine cable crossing corridor where construction related ship traffic will be highest. Most Sea Turtles in Atlantic Canada occur well south of the Strait of Belle Isle, primarily along the Scotian Shelf and Grand Banks. In addition, the relatively slow speed of the vessels during installation of the subsea cable (up to 0.4 knots) and construction of the rock berm (up to 2 knots) will allow Sea Turtles time to move out of the way of vessels. Project vessels will also maintain a constant course and speed whenever possible. In addition, if a Sea Turtle is observed in the direct path of the vessel, Project vessels will detour around Sea Turtles if feasible. As a result, Sea Turtle injury or mortality is not likely from vessel collisions during the Construction phase.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on Sea Turtles are as follows:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations;
- Low magnitude because the number of affected Sea Turtles is likely to represent a very small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Sea Turtles;
- Limited to the RSA;
- Short-term duration because effects are limited to the Construction period (June to November in Year 1 of a four-year construction phase) and will not occur after vessels have left the area; and
- Low in frequency as the installation of the subsea cable and placement of rock berms will occur only once during the Construction phase.

There is a high degree of confidence that the level of residual effect will not be greater than predicted because few Sea Turtles are likely to occur in the RSA during the Construction phase, particularly within the Strait of Belle Isle RSA Component, and in addition Project-specific acoustic modelling supports this level of confidence.

14.3.6 Operations and Maintenance

14.3.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

Operations and Maintenance activities that are most relevant to the Marine Mammals and Sea Turtles VEC include vessel activity associated with major system repairs and routine line inspections. Maintenance activities will be less frequent, of shorter duration, and involve fewer vessels than during the Construction phase. A review of existing knowledge on Marine Mammal and Sea Turtle response to vessels and the potential for collisions was provided in Section 14.3.5. There is limited potential that Sea Turtles may be affected by EMFs generated from the operation of the electrodes, including monopolar operations. However, few Sea Turtles are expected to occur near these sites. It is uncertain if marine mammals are influenced by EMFs.

There is also potential for Operations and Maintenance activities to cause changes in Marine Mammal and Sea Turtle health if there are accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons). However, this effect is not analyzed in detail given the low probability of occurrence (with proper mitigation measures in place) and the low probability that Marine Mammals and Sea Turtles would come in contact with deleterious substances given their tendency to avoid at least the immediate area around vessels.

Mitigation measures that Nalcor will apply to Project activities during the Operations and Maintenance phase are as follows:

- Project vessels will maintain constant course and speed to the extent practical;
- Project vessels will detour around Marine Mammals and Sea Turtles if feasible;
- routine visual inspections of the submarine cable will be completed with an ROV;
- screen / armouring of the cable is on the same electric potential as the outside ambient so that the electric field is confined to the inside of the cable;
- submarine cable armour and protective rock berm will minimize electric fields;
- the rock berm will serve as a partial barrier to the EMF generated by the cable;
- electrodes will be designed to minimize electric and magnetic fields (e.g., through electrode design, electrode materials, electrode surface area, low resistivity surroundings);
- operation of electrodes under normal conditions as a bi-pole system will involve only very low levels of electric current flowing through the electrodes (<1%);
- the HVdc system is designed to require less than 40 hours per year of monopolar operations (100%) using the electrode;
- minimization of contact area between the shoreline saltwater pond and the breakwater to ensure a safe voltage gradient on the sea side of the breakwater; and
- biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

14.3.6.2 Existing Knowledge

There have been no direct or systematic studies of the effects of the operation of electrodes and submarine cables on Marine Mammals and Sea Turtles. As reviewed in Section 14.3.5, there have been numerous studies of marine mammal response to vessels and limited studies of Sea Turtles that are relevant to the assessment of maintenance activities on this VEC.

O'Brien et al. (2006) did note that there have been no marine mammal strandings at or near an electrode site associated with a high voltage direct current (HVdc) cable between the North and South Islands of New Zealand. The HVdc system has been in operation for over 40 years (Table 14.3.6-1). No other details relevant to marine mammals were provided in that report.

Table 14.3.6-1 Existing Knowledge (Operations and Maintenance): Effects of Similar Projects on Marine Mammals and Sea Turtles

Reference	Study / Project Context	Summary of Findings
O'Brien et al. (2006)	Environmental review based on 40 years of operation of an HVdc transmission link between the North and South Islands of New Zealand and the associated electrode sites.	No marine mammal strandings have occurred near the electrode site.

14.3.6.3 Operations and Maintenance Effects: Baleen Whales

Behavioural Responses to Submarine Cables and Electrode Emissions

The behavioural effects of exposure to emissions from submarine cables and electrodes on Marine Mammals and Sea Turtles are issues / questions which have been raised in relation to the Project. Some understanding of the fundamentals of EMFs is required to enable interpretation of potential effects, so background information is provided below on this topic. In addition, background information is provided on the potential for marine mammals to detect EMFs.

Background Information on Electromagnetic Fields

EMFs are produced by the flow of current through cables and conductors, and also as electric current passes through other media such as the sea and soil. EMFs consist of an electric field component (E) and a magnetic field component (H) that travel together in space at the speed of light. The magnitude of the EMF at a given point is dependent on the distance from the conductor, and the permeability of the medium. The electrode during operations will produce an EMF as current will flow into the sea and surrounding soil. As discussed in Section 14.3.4, the strength of the magnetic field at various distances from the electrode has been modelled to determine the zone of influence during both normal bipolar operations and upset conditions when the electrode is operating under monopolar operations (i.e., at 100%).

To predict the potential effects of electromagnetic emissions on marine fauna, it is first necessary to have a basic understanding of natural and anthropogenic sources. Secondly, information is required on how the various components of the ecosystem will respond to these emissions. Third, it is important to understand the nature and type of EMFs that the Project will generate.

Earth's Geomagnetic Field

The Earth generates a magnetic field with north - south polarity which forms the basis of the magnetic compass. This field is periodically disturbed by anomalies in the Earth's crust and by solar storms. Two principal features of the Earth's geomagnetic field are inclination and intensity. At any point on the Earth, magnetic field lines intersect the planet's surface at a specific angle (inclination) relative to the horizontal, ranging from 0° (parallel to the Earth) at the geomagnetic equator, to 90° at the geomagnetic poles. Because the geomagnetic field is roughly symmetrical around the Earth's surface, lines of equal inclination exist as equivalent rough lines of latitude around the geomagnetic axis (Wiltschko and Wiltschko 1995; Kirschvink et al. 1986).

The intensity of the geomagnetic field also varies. It is highest near the magnetic poles at 60,000 nano Tesla (nT), is about 40,000 to 50,000 nT at mid latitudes, and decreases to about 30,000 nT at the geomagnetic equator. The field value in the Strait of Belle Isle is in the order of 54,000 nT (see Figure 14.2.6-1).

Superimposed on this global magnetic field are local magnetic deviations, distortions, and anomalies that vary irregularly over the Earth's surface. This geomagnetic topography consists of magnetic hills and valleys of varying size and intensity that are associated with the magnetic nature of underlying rock and localized dynamics in the Earth's iron core. High concentrations of magnetized rock localized in areas of low magnetic concentration create strong magnetic gradients. Regional gradients typically are subtle. In north-eastern North America, field intensity changes at about 3.4 nT/km, whereas the regional gradient across central Europe is 2.5 nT/km.

The Earth's magnetic field is also subject to short- and long-term variations. Solar electromagnetic radiation impinging on the Earth's surface can cause daily fluctuations in field intensity of up to 30 nT and shifts in inclination of up to 0.33°. These daily perturbations vary with latitude and season. Magnetic storms associated with sun spot activity also cause fluctuations of 200 nT or more. The geomagnetic field also undergoes long-term drift with field intensity varying about 0.05% per year with periods of several thousand years. There is also a westward drift in the field of about 0.2° longitude per year (Wiltschko and Wiltschko 1995; Kirschvink et al. 1986). There are also many anthropogenic sources of electromagnetic fields in the ocean (e.g., fibre optic cables, transmission lines).

Nonetheless, the Earth's geomagnetic field potentially provides a reliable global positioning system for any organism that can detect and interpret the magnetic landscape in terms of relative position and / or directional orientation.

A large variety of organisms have been shown to respond to geomagnetic cues: magnetotactic bacteria (Kirschvink 1980), protists (Bazylinski et al. 2000), gastropods (Lohmann and Willows 1987), crustaceans (Lohmann et al. 1995), insects (Riveros and Srygley 2010), bony fish (Walker 1984), amphibians (Diego-Rasilla et al. 2010), and some species of Sea Turtles (Goff et al. 1995), birds (Wiltschko et al. 2010) and migratory whales (Kirschvink et al. 1986).

Induction

The concept of electrical induction is a key element for understanding the pathway by which electrical transmissions may disrupt nearby marine life. As defined by Faraday's Law, an electrical current is generated, or "induced", in any conductor moving through a magnetic field. Magnetic fields have polarity (north and south poles) and the direction of current flow within a conductor is a function of the direction in which the conductor moves relative to the north - south orientation of the magnetic field. If a conductor moves from left to right relative to the north - south orientation, current will flow in one direction, and if it moves from the right to the left current will flow in the opposite direction. If a conductor is moved back and forth within the magnetic field, the current will alternately flow in opposite directions; an ac is generated. A current may also be induced in a stationary conductor if the surrounding magnetic field is in motion. Either way, electrical induction depends upon movement. Either a conductor must move within a magnetic field, or a magnetic field must move past a stationary conductor. If both elements are motionless, no electric current is induced.

Just as a magnetic field induces an electric current in a conductor, an electric current creates a magnetic field in the space surrounding the conductor. When current flow is initiated a magnetic field expands around the conductor. When current flow eventually stabilizes, the surrounding magnetic field stops expanding and becomes a static magnetic field. If the current is shut off, the magnetic field collapses. The polarity of the magnetic field depends on the direction of current flow. When current flow reverses in a conductor, the polarity of the surrounding magnetic field reverses.

The relevance of electrical induction to the underwater transmission of electricity is that all animals are electrical conductors. Biological organisms continually generate internal voltage gradients and electrical currents including those associated with the nervous system, all types of biochemical reactions ranging from digestion to higher brain functions, sensory and motor mechanisms, reproductive processes, and membrane integrity. EMFs of sufficient strength have the ability to induce micro-currents within an organism and possibly disrupt these normal electrical functions. Induction of micro-currents could be associated with either the electrical or magnetic component of the electromagnetic wave.

Geomagnetic Navigation

It is generally believed that the planet's geomagnetic field may provide a primary template that many forms of life use as a navigation coordinate system. It is the dominant feature that underlies the theory of geomagnetic navigation in animals. As such, any disruption to this field could have adverse effects on marine fauna.

A bi-coordinate positioning system is a prerequisite for "true navigation". For an animal to determine its location using magnetic parameters alone, it must be able to perceive at least two distinct parameters of the Earth's geomagnetic field, and these parameters must vary relative to each other across the Earth's surface such that a grid is formed from which a position can be fixed. For animals that migrate long distances, such a system would provide not only a source of directional information, but a source of positional information as well. However, for animals to navigate using this type of system, they must be able to detect small gradients in the geomagnetic field on the order of 5 to 10 nT/km and an inclination of about 0.01°/km. They must do this while at the same time compensating for daily changes in magnetic conditions from local anomalies or solar events on the order of 30 to 200 nT and in inclination of about 0.33° (Wiltschko and Wiltschko 1995; Kirschvink et al. 1986). In addition, geomagnetic drift over an individual's life time could cause errors in position determination.

The two dominant types of theories for geomagnetic navigation in animals are: (i) magnetoreception model (Wiltschko and Wiltschko 1995) using magnetite (found in many animals) and some cellular level intermediary such as bacteria, and (ii) the radical pairs models (Ritz et al. 2000; Schulten and Windemuth 1986) suggesting the use of specialized chemical processes to transfer magnetic information.

Even though the idea of geomagnetic navigation is a major field of scientific study and there is much support for its theory, the mechanisms by which animals might implement a bi-coordinate mapping system and overcome its many challenges remain unknown. Adding to the complexity is the role that other environmental cues such as olfaction, celestial navigation, visual landmarks, currents, and temperature / salinity gradients may play, either interactively with geomagnetic navigation or at times dominating the navigation process.

Marine Mammal Detection and Use of Electromagnetic Fields

Evidence of geomagnetic detection and orientation in cetaceans is limited. Most evidence that cetaceans may be able to detect geomagnetic cues comes from analyses of mass stranding data.

The first major study to suggest the existence of geomagnetic orientation in cetaceans was by Klinowska (1986, 1985). Klinowska (1985) analyzed 3,000 cetacean strandings that occurred over a 70-year period in the United Kingdom and found a pronounced difference between the passive strandings of dead animals and the active strandings of live animals. Whereas stranding sites for dead and decomposed bodies were widely distributed in different coastal regions, live strandings occur exclusively where geomagnetic contour lines ran perpendicular to, or cut across, the coastline. The author proposed that whales traveling along geomagnetic contours would be diverted onshore in such areas. Active stranding sites were not correlated with tides, currents, common hydrography, or common geography. Most of the dead strandings involved species that live primarily in coastal waters. In contrast, active strandings were largely associated with oceanic species. This led Klinowska (1985) to speculate that these animals may have been outside familiar deep-water areas and hence exposed, perhaps for the first time, to the problems involved in following geomagnetic topography in shallow coastal waters.

Klinowska (1986) reported that live strandings were associated with geomagnetic disturbances and that strandings generally occurred 1-2 days after major geomagnetic storms. Animals also appeared to mass strand at places where lines of equal geomagnetic intensity ran parallel to the coastline and then suddenly turned to run perpendicular to the shore. The author postulated that animals make key navigational mistakes at some distance from the shore and that these errors ultimately result in live strandings. These events are associated with geomagnetic disturbances and that the pattern of geomagnetic disturbance, not the absolute level of the disturbance, is the key factor for live strandings. Klinowska (1986) further theorized that cetaceans time their migrations by detecting daily variations in the Earth's magnetic field that they use as a "biological travel clock". Geomagnetic disturbances may disrupt the daily cycle and the "clock" causing navigational errors. Klinowska (1986) further found that a connection between live strandings data and higher geomagnetic disturbances appeared in the most northerly group. This was also the only group to incur geomagnetic disturbances that exceeded 3.0 on the K-index, a meteorological index used to categorize the intensity of geomagnetic disturbances. This corresponds to a disturbance of 30 to 40 nT.

Kirschvink et al. (1986) and Kirschvink (1990) found similar and / or supporting results for some US strandings data of both toothed and Baleen Whales. Kirschvink et al. (1986) hypothesized that cetaceans possess a highly developed sensitivity to the geomagnetic field which enables them to use local variations in it for guidance, likely through the presence of specialized receptors capable of transducing weak geomagnetic stimuli to the nervous system. Total intensity variations of as little as 50 nT (0.1% of the total field) were sufficient to influence stranding location (Kirschvink et al. 1986).

A study of fin whale sightings taken during Cetacean and Turtle Assessment Program aerial surveys over the continental shelf off the north-eastern US provided results consistent with the hypothesis that fin whales (and perhaps other Baleen Whale species) possess a magnetic sense used to travel in areas of low magnetic field gradient and possibly low magnetic intensity during migration (Walker et al. 1992). It remains unclear whether geomagnetic cues could be used in other non-migratory navigational activities. Kirschvink et al. (1986) suggested that geomagnetic cues, such as magnetic “hills” produced by seamounts superimposed on the undulating magnetic topography of the oceans, could be used by cetaceans to find areas, such as seamounts, often associated with higher levels of productivity than the surrounding waters. Therefore, cetaceans might show a seasonal and / or regional shift in magnetic state depending on the behaviour being undertaken (use of lows during migration and highs during feeding; Kirschvink et al. 1986).

Vanselow and Ricklefs (2005) analyzed 300 years of North Sea strandings data for the sperm whale and found there to be a correlation with long-term sun spot cycles and activity. The shorter the sun spot cycle, the lower were the number of strandings. They speculated that variations in the Earth’s magnetic field caused by variable energy fluxes from the sun may cause a temporary disorientation of the animals. Data were also consistent with longer sun spot cycles recorded in the last two decades of the 20th century and a notable increase in sperm whale strandings in the North Sea. In a follow-up study, Vanselow et al. (2009) arrived at the same conclusion.

In contrast to authors who cite evidence for geomagnetic navigation in cetaceans, there are others who report no such indications. Brabyn and Frew (1994) examined whale strandings in New Zealand dating back to 1940 specifically following the analytical methods used by Kirschvink et al. (1986) and Klinowska (1985). The New Zealand cetacean strandings showed no relationship to regions where geomagnetic contours were perpendicular to the coastline nor to geomagnetic maxima or minima. The authors note that one explanation for the difference in their results and those of Kirschvink et al. (1986) and Klinowska (1985) is that much of New Zealand is surrounded by a shallow marine platform characterized by no consistent pattern in geomagnetic anomalies. In contrast, the sea floor off the east coast of the US and the United Kingdom is characterized by strong magnetic lineation. In effect, New Zealand does not have a geomagnetic field of sufficient pattern or intensity to support a cetacean navigation system.

In summary, some oceanic cetaceans in some situations may use geomagnetic cues for navigation, and are potentially sensitive to changes from the “normal” as low as 30 nT. However, this is not true in all cases, has never been observed directly, and is difficult to rationalize when the marine environment is a relatively noisy place (i.e., on the order of hundreds of nT) in terms of electromagnetic signals, and marine mammals must use a variety of cues to navigate reliably.

EMF Modelling and Assessment of Effects

The 900 MW Project will have two main sources of EMFs in the marine environment: (i) three submarine HVdc cables (350 kV) and (ii) the two shore electrodes (L'Anse au Diable in the Strait of Belle Isle and Dowden's Point in Conception Bay).

It is important to note that the Project current will be direct current (i.e., dc) and the electrical component of the EMF can be considered to have a frequency of 0 Hz. This is non-ionizing radiation as compared to ionizing radiation of X-rays and gamma rays (very high frequencies up to 10^{16} Hz). As such, dc and low frequency ac (e.g., 60 Hz of household current) have little if any potential to cause health effects on animals (CEA 2010; Health Canada 2010; WHO 2007). It also should be noted that some of the reported subtle effects of electric fields on marine organisms originate from laboratory experiments conducted using ac current.

The shielded and buried cables are not expected to generate an external electric field. However, a static magnetic field will be generated around the cables and a weak electrical current (induced current) will be generated by any conductor moving through this field (e.g., fish) (Faraday's Law). There also may be a weak electric field if there is any current leakage or stray current from various parts of the transmission system but these small potential sources are not considered here because of uncertainties in modelling such small variable sources and the fact that they are unlikely to produce measurable effects. The specific size of the field will depend on local conditions but would be in the order of 150 m as calculated by the Biot-Savart Formula (Worzyk 2009). The magnetic field strength attenuates rapidly from 260 µT (260,000 nT) at 1 m from the cable to 26 µT (26,000 nT) at 10 m as calculated using the Biot-Savart Formula using a maximum current of 1,286 amperes (A).

The transmission system will be operated in the bipolar mode during normal operational conditions and thus, relatively little EMFs will be emitted at the electrodes (<1% of current producing an electric field <1.25 V/m in the seawater on the sea side of the breakwater; see Tables 3-2 and 3-4 in Hatch 2011). During upset conditions, electrodes will create greater EMFs.

A potential zone of influence (ZOI) of the Dowden's Point electrodes on marine fauna can be estimated using the modelling of the magnetic flux density (Hatch Ltd. 2011) and the sensitivities of marine animals as reported in the literature. To provide a conservative ZOI, a water depth of 0 m and the higher amperage 320 kV HVdc system were chosen as the parameters. There would be two ZOI: (i) from a continuous and normal bipole system operation imbalance current at 14.06 A; and (ii) from the fault condition of monopole operation with a fault current of 2,109 A (predicted to occur sporadically for a maximum total of less than 40 hours per year).

As a conservative approach, a 0 m water depth was selected for this assessment because the induced magnetic field intensity at the surface is greater than at any other point in the water due to partial cancellation of flux at the top layer of water. The induced flux intensities will be zero at a point where currents in the water above and below the point are equal. The flux intensity at the bottom of the sea will be less than at the surface and in the opposite direction (about the z-axis). The change of sea surface elevation with the tide will result in lower magnetic field intensity since current magnitudes will remain the same but the observation will be farther from the water layers.

The 320 kV modelling scenario was selected because it would operate at a higher amperage than the 350 kV system (i.e., the proposed Project) and thus will create somewhat greater electric and electromagnetic fields.

A threshold of effects on marine fauna at a magnetic flux density of 200 nT (2×10^{-7} T) is a reasonable (and conservative) value to use to define the ZOI of the electrodes. Referring to Hatch Ltd. (2011), a surface ZOI for normal operations can be defined at some distance from the electrodes of equal to or less than 50 to 100 m (see Hatch Ltd. 2011, Tables 3-15 and 3-19, B_{res} values reported as natural Earth values plus those induced by the Project).

The upset condition where the system is operating in monopolar operation (i.e., maximum continuous current) results in a ZOI radius for the electrodes on the order of 500 m for L'Anse au Diable and Dowden's Point (see Hatch Ltd. 2011, Table 3-13 and 3-17, B_{res} values).

It should be noted that the 200 nT threshold was chosen as a conservative level where a diversity of marine animals (both invertebrates and vertebrates) may be able to detect and react (e.g., Kirschvink 1990; Semm and Beason 1990; Kirschvink et al. 1986; Walker and Bitterman 1989). Several species have been exposed to levels many times above this level with no reactions and no ill effects. Not all individuals or species will always react; and not all reactions will necessarily be negative. Delay or alterations in migratory patterns would be a potential negative effect but animals in the natural environment regularly encounter anomalies. For example, there are at least 27 geomagnetic events per year of 200 nT or more (NOAA 2011, internet site).

Overall, given the rapid attenuation of magnetic field strength, the relative small area affected, the brief period of exposure, the likelihood that Baleen Whales rely on more than one navigation system, and their capacity for avoidance, EMFs generated by the Project are not likely to affect Baleen Whale behaviour. In addition, few Baleen Whales are likely to occur close to the shoreline electrode sites.

Behavioural Responses to Vessel Traffic

As described in Section 14.3.5, Baleen Whales may avoid vessels, including those involved with routine line inspections and major system repairs. Changes in behaviour are not likely to affect Baleen Whale migration; humpback and other Baleen Whales would be likely to detour around Project vessels and any disruption to feeding is expected to be localized and temporary. Baleen Whales are not considered at risk of collision with Project vessels during maintenance activities because vessels are expected to travel at reduced speeds (<2.0 knots during the remotely operated vehicle (ROV) inspections; 10-12 knots for transit) and maintain a constant course and speed whenever possible. In addition, Project vessels will detour around Baleen Whales if feasible.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance, including operation of the electrodes during normal (bipolar) and upset (monopolar) conditions, on Baleen Whales as follows:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations;
- Low magnitude because the number of affected Baleen Whales is likely to represent a small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Baleen Whales;
- Limited to the RSA, with the effects related to EMF limited to the LSA;
- Short-term to far future duration because inspection and maintenance and EMFs will be generated throughout the Operations and Maintenance phase; and
- Low to continuous in frequency as inspection and maintenance will occur and EMFs will be generated throughout the Operations and Maintenance phase.

There is a moderate to high degree of confidence that the level of residual effect on Baleen Whales will not be greater than predicted. EMF and acoustic modelling results and a relatively good understanding of Baleen Whale response to vessel traffic support this level of confidence. There is some uncertainty about the effects of EMFs on Baleen Whales. Uncertainties are addressed in the EIS through conservative estimates and assumptions, monitoring and through adaptive management.

14.3.6.4 Operations and Maintenance Effects: Toothed Whales

Behavioural Responses to Submarine Cables and Electrode Emissions

As discussed above, the ZOI for marine animals in general is based on 200 nT threshold of magnetic flux density. Referring to Hatch Ltd. (2011), a surface ZOI for normal operations can be defined at some distance from the electrodes of equal to or less than 50 to 100 m (see Hatch Ltd. 2011, Tables 3-15 and 3-19, B_{res} values reported as natural Earth values plus those induced by the Project).

The upset condition where the system is operating in monopolar operation (i.e., maximum continuous current) results in a ZOI radius for the electrodes on the order of 500 m for L'Anse au Diable and Dowden's Point (see Hatch Ltd. 2011, Table 3-13 and 3-17, B_{res} values).

Overall, given the rapid attenuation of magnetic field strength, the relative small area affected, the brief period of exposure, the likelihood that Toothed Whales rely on more than one navigation system, and their capacity for avoidance, EMFs generated by the Project are not likely to affect Toothed Whale behaviour. In addition, few Toothed Whales are likely to occur close to the shoreline electrode sites.

Behavioural Responses to Vessel Traffic

As described in Section 14.3.5, Toothed Whales may avoid vessels, including those involved with routine line inspections and major system repairs. Changes in behaviour are not likely to affect Toothed Whale migration; Toothed Whales will likely detour around Project vessels and any disruption to feeding is expected to be localized and temporary. Toothed Whales are not likely to collide with Project vessels during maintenance activities because vessels will to travel at reduced speeds (<2.0 knots during the ROV inspections; 10-12 knots for transit) and maintain a constant course and speed whenever possible. In addition, Project vessels will detour around Toothed Whales if feasible.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance, including operation of the electrodes during normal (bipolar) and upset (monopolar) conditions, on Toothed Whales are as follows:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations;
- Low magnitude because the number of affected Toothed Whales will likely represent a very small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Toothed Whales;
- Limited to the RSA, with the effects related to EMF limited to the LSA;
- Short-term to far future duration because inspections and maintenance will occur and EMFs will be generated throughout the Operations and Maintenance phase; and
- Low to continuous in frequency as inspection and maintenance will occur and EMFs will be generated throughout the Operations and Maintenance phase.

There is a moderate to high degree of confidence that the level of residual effect on Toothed Whales will not be greater than predicted. EMF and acoustic modelling results and a relatively good understanding of Toothed Whale response to vessel traffic support this level of confidence. There is some uncertainty about the effects of EMFs on Toothed Whales. Uncertainties are addressed in the EIS through conservative estimates and assumptions, monitoring and through adaptive management.

14.3.6.5 Operations and Maintenance Effects: Pinnipeds

Behavioural Responses to Submarine Cables and Electrode Emissions

There is no evidence to indicate that Pinnipeds, including seals that occur in the RSA, can detect or are affected by EMFs. It is highly unlikely that seals would be directly affected by EMFs produced during the Project, particularly given the rapid attenuation of magnetic field strength, the relative small area affected (less than 100 m and 500 m ZOIs for normal and upset operational conditions, respectively), and the brief period of exposure. In addition, few seals are expected to occur close to the shoreline electrode sites.

Behavioural Responses to Vessel Traffic

As described in Section 14.3.5, some seals will likely avoid vessels while other seals may be curious and approach the vessels. Seal avoidance of vessels involved with periodic maintenance activities would not seriously affect migration and / or feeding activities.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on Pinnipeds are as follows:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations;
- Low magnitude because the number of affected Pinnipeds is likley to represent a small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Pinnipeds;
- Limited to the RSA;
- Short-term duration because any change in Pinniped behaviour will be limited to maintenance activities in a given year; and
- Low in frequency as maintenance activities are likely to occur at most once per year during the Operations and Maintenance phase.

There is a high degree of confidence that the level of residual effect on Pinnipeds will not be greater than predicted. Acoustic modelling results and a relatively good understanding of Pinniped response to vessel traffic support this level of confidence.

14.3.6.6 Operations and Maintenance Effects: Sea Turtles

Behavioural Responses to Submarine Cables and Electrode Emissions

Background information on sea turtle detection and use of electromagnetic fields is provided below, followed by the effects assessment.

Sea Turtle Detection and Use of Electromagnetic Fields

Juvenile sea turtles are theorized to navigate by sensing and orienting to the Earth's geomagnetic field. There is little scientific evidence that adult sea turtles use geomagnetic navigation.

Lohmann (1991) was one of the first researchers to provide evidence that Sea Turtles may be capable of detecting the Earth's geomagnetic field. Newly hatched loggerhead sea turtles were tested under laboratory conditions near Fort Pierce, Florida. When hatchlings were allowed to move freely within a test tank there was a statistically significant tendency for them to swim toward the north-east at a mean direction of 42°. The results were interesting given the life-history pattern of loggerhead turtles that nest on the east coast of Florida. Hatchlings emerging from nests immediately establish offshore headings toward the Gulf Stream Current (Salmon and Wyneken 1987) and the North Atlantic Gyre (Carr 1987, 1986). Turtles entrained into the Gyre are passively transported eastward across the North Atlantic to the eastern Atlantic, then drift south past the Azores and Canary Islands, eventually returning to the western Atlantic via the North Equatorial Current (Carr 1986). This trans-Atlantic journey has been repeatedly documented (Bolton et al. 1992, 1990; Eckert and Martins 1989; Manzella and Fontaine 1988). Lohmann (1991) reasoned that the results of the laboratory experiment were consistent with this migration pattern. Swimming to the north-east from Fort Pierce would take the turtles directly to the Gulf Stream. A second batch of turtles was tested under identical conditions except that the Earth's geomagnetic field was artificially reversed in polarity by 180°. Turtles from this second group exhibited a statistically significant tendency to swim in a SSW direction at a mean angle of 196°—essentially opposite to that of the group tested under normal geomagnetic conditions. Results suggested that the turtles were orienting in response to the polarity of the Earth's geomagnetic field.

Since then, studies have shown that juvenile loggerhead and leatherback sea turtles can detect changes in their surrounding geomagnetic field (Avins and Lohmann 2004, 2003; Irwin and Lohmann 2002; Goff et al. 1998, 1995; Lohmann and Lohmann 1996, 1994a, 1994b, 1993; Light et al. 1993; Salmon and Lohmann 1989).

In contrast to the case for young sea turtles, there is little scientific evidence that adult sea turtles use geomagnetic navigation. Papi et al. (2000) attached six powerful static magnets to each of seven adult female green turtles on Ascension Island and then tracked the turtles by satellite during their 5-6 week migration to feeding grounds off the coast of Brazil. Courses were compared to those for eight control turtles without magnets. No differences between magnetically disturbed and undisturbed turtles were observed relative to navigational performance or the straightness of course. In contrast, Luschi et al. (2001) conducted similar experiments and found that magnetically disturbed turtles swam more erratic routes during their migration, the difference from controls being significant.

EMF Modelling and Assessment of Effects

Studies have shown that juvenile loggerhead and leatherback sea turtles seem to navigate by sensing and orienting to the Earth's geomagnetic field. There is little scientific evidence that adult sea turtles use geomagnetic navigation. Few, if any Sea Turtles are expected to occur in the Strait of Belle Isle RSA Component where the submarine cables will occur and any EMF produced will attenuate rapidly. Similarly, few Sea Turtles are expected to occur in the L'Anse au Diable RSA Component. It is possible that some leatherback sea turtles may occur within and near the Dowden's Point LSA Component (see Figure 10.6.8-2). Sea Turtles which occur in coastal Newfoundland waters are generally adults (Lawson 2011, pers. comm.) and as such, are not expected to rely on EMFs for navigation. It is uncertain if Sea Turtles that occur near the electrode sites will be able to detect EMFs and whether this may lead to avoidance of the area, but it is unlikely. If it is conservatively assumed that adult sea turtles are affected by a magnetic flux density of 200 nT, then the ZOI during normal operation of the electrode sites is equal to or less than 50 to 100 m; during upset conditions the ZOI on the order of 500 m.

Overall, given the rapid attenuation of magnetic field strength, the relative small area affected by the assumed 200 nT ZOI, the brief period of exposure, the likelihood that Sea Turtles that occur in the RSA do not use EMFs as part of their navigation system, and their capacity for avoidance, EMFs generated by the Project are not expected to affect sea turtle migration. In addition, few Sea Turtles are expected to occur close to the shoreline electrode sites.

Behavioural Responses to Vessel Traffic

Few, if any Sea Turtles are expected to occur in the Strait of Belle Isle RSA Component where most vessel traffic associated with maintenance activities will occur. Project vessels will detour around Sea Turtles if feasible. Maintenance of the electrode sites at L'Anse au Diable and Dowden's Point will not involve vessels. Few Sea Turtles are expected near these sites, particularly at the L'Anse au Diable site. As described in Section 14.3.5, Sea Turtles may exhibit avoidance of vessels, including those involved with routine line inspections and major system repairs.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance, including operation of the electrodes during normal (bipolar) and upset (monopolar) conditions, on Sea Turtles are as follows:

- Adverse because of behavioural effects (e.g., avoidance) due to vessel operations and perhaps due to exposure to EMFs;
- Low magnitude because the number of affected Sea Turtles will likely represent a very small portion of fauna in the general vicinity of Project activities and to not pose serious risk to Sea Turtles;
- Limited to the RSA, with the effects related to EMF limited to the LSA;
- Short-term to far future duration because inspection and maintenance will occur and EMFs will be generated throughout the Operations and Maintenance phase; and
- Low to continuous in frequency as inspection and maintenance will occur and EMFs will be generated throughout the Operations and Maintenance phase.

There is a moderate to high degree of confidence that the level of residual effect on Sea Turtles will not be greater than predicted because few Sea Turtles are likely to occur in the RSA, particularly near the electrode sites. Also, if some Sea Turtles are affected by Operations and Maintenance activities, effects are likely to be localized and temporary. There is some uncertainty about the effects of EMFs on Sea Turtles. Uncertainties are addressed in the EIS through conservative estimates and assumptions, monitoring and through adaptive management.

14.3.7 Environmental Effects Summary and Evaluation of Significance

To this point of the assessment of Project activities / components on the Marine Mammals and Sea Turtles VEC, the analysis has been focused on the individual KIs associated with the VEC. This section compiles the KI assessment information and presents an overall conclusion for the VEC.

14.3.7.1 Summary of Environmental Effects

The summary of the environmental effects analysis is presented in Table 14.3.7-1. The overall likely residual environmental effect of combined construction, and Operations and Maintenance activities associated with the Project on the Marine Mammals and Sea Turtles VEC is minimal.

Table 14.3.7-1 Environmental Effects Analysis Summary: Marine Mammals and Sea Turtles VEC

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Baleen Whales	**Adverse** – There will be avoidance of Construction activities. Hearing impairment and mortality are considered unlikely.	**Low to Moderate** – Avoidance of Construction activities may fall within the normal range of behavioural variability but may also be beyond that associated with normal range of variability. Effects are unlikely to pose a serious risk to the VEC or represent a management challenge.	**Local to Regional** – Baleen Whales may only avoid the immediate area around Construction activities or avoidance may extend beyond the LSA but will be confined to the RSA.	**Short-term** – Avoidance is expected to be temporary and is not predicted to extend beyond the period Construction activities occur near Baleen Whales.	**Low** – Avoidance by Baleen Whales at a particular location is predicted to occur only once during Construction.
Toothed Whales	**Adverse** – There will be avoidance of Construction activities. Hearing impairment and mortality are considered unlikely.	**Low to Moderate** – Avoidance of construction activities may fall within the normal range of behavioural variability but may also be beyond that associated with normal range of variability. Effects are unlikely to pose a serious risk to the VEC or represent a management challenge.	**Local to Regional** – Toothed Whales may only avoid the immediate area around Construction activities or avoidance may extend beyond the LSA but will be confined to the RSA.	**Short-term** – Avoidance is expected to be temporary and is not predicted to extend beyond the period Construction activities occur near Toothed Whales.	**Low** – Avoidance by Toothed Whales at a particular location is predicted to occur only once during Construction.

Table 14.3.7-1 Environmental Effects Analysis Summary: Marine Mammals and Sea Turtles VEC (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Pinnipeds	**Adverse** – There will likely be avoidance of Construction activities. Hearing impairment is considered unlikely.	**Low to Moderate** – Avoidance of Construction activities may fall within the normal range of behavioural variability but may also be beyond that associated with normal range of variability. Effects are unlikely to pose a serious risk to the VEC or represent a management challenge.	**Local to Regional** – Pinnipeds may only avoid the immediate area around construction activities or avoidance may extend beyond the LSA but will be confined to the RSA. Potential hearing impairment effects would be confined to the immediate area around Project vessels.	**Short-term** – Avoidance is expected to be temporary and is not predicted to extend beyond the period Construction activities occur near toothed Pinnipeds.	**Low** – Avoidance by Pinnipeds at a particular location is predicted to occur only once during Construction.
Sea Turtles	**Adverse** – There will be avoidance of Construction activities. Hearing impairment and mortality are considered unlikely.	**Low** – Avoidance of Construction activities is expected to fall within the normal range of behavioural variability.	**Local to Regional** – Sea Turtles may only avoid the immediate area around Construction activities or avoidance may extend beyond the LSA but will be confined to the RSA.	**Short-term** – Avoidance is expected to be temporary and is not predicted to extend beyond the period Construction activities occur near Sea Turtles.	**Low** – Avoidance by Sea Turtles at a particular location is predicted to occur only once during Construction.
Summary of Likely Residual Construction Effects on Marine Mammals and Sea Turtles: The residual effects of Construction activities on Marine Mammals and Sea Turtles will likely to be limited to behavioural responses to construction noise. Considering the known responses of these animals to vessel noise and the results of acoustic modelling, and the mitigation proposed by Nalcor, residual effects do not pose a serious risk to the Marine Mammals and Sea Turtles VEC, are predicted to be of short-term duration and to occur within the RSA.					

Table 14.3.7-1 Environmental Effects Analysis Summary: Marine Mammals and Sea Turtles VEC (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Operations and Maintenance					
Baleen Whales	**Adverse** – There will be avoidance of maintenance activities and perhaps a behavioural response to EMFs. Mortality from vessel collisions is considered unlikely.	**Low** – Avoidance of vessels conducting maintenance or of EMFs is expected to fall within the normal range of behavioural variability.	**Local to Regional** – Baleen Whales may avoid the immediate area around maintenance / operation activities or avoidance may extend beyond the LSA but will be confined to the RSA.	**Short-term to Far Future** – Any effects will be limited to maintenance activities in a given year. – Any effects (albeit unlikely) from EMF could persist for the duration of operations.	**Low to Continuous** – Any effects of maintenance activities are expected to occur at most once per year. – Any effects (albeit unlikely) of EMFs could be continuous for the duration of operations.
Toothed Whales	**Adverse** – There will be avoidance of maintenance activities and perhaps a behavioural response to EMFs. Mortality from vessel collisions is considered unlikely.	**Low** – Avoidance of vessels conducting maintenance or of EMFs is expected to fall within the normal range of behavioural variability.	**Local to Regional** – Toothed Whales may avoid the immediate area around maintenance / operation activities or avoidance may extend beyond the LSA but will be confined to the RSA.	**Short-term to Far Future** – Any effects will be limited to maintenance activities in a given year. – Any effects (albeit unlikely) from EMF could persist for the duration of operations.	**Low to Continuous** – Any effects of maintenance activities are expected to occur at most once per year. – Any effects (albeit unlikely) of EMFs could be continuous for the duration of operations.

Table 14.3.7-1 Environmental Effects Analysis Summary: Marine Mammals and Sea Turtles VEC (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	Magnitude	Geographic Extent	Duration	Frequency
Pinnipeds	**Adverse** – There will be avoidance of maintenance activities.	**Low** – Avoidance of vessels conducting maintenance is expected to fall within the normal range of behavioural variability.	**Local to Regional** – Pinnipeds may avoid the immediate area around maintenance / operation activities or avoidance may extend beyond the LSA but will be confined to the RSA.	**Short-term** – Any effects will be limited to maintenance activities in a given year.	**Low** – Any effects of maintenance activities are expected to occur at most once per year.
Sea Turtles	**Adverse** – There will be avoidance of maintenance activities and perhaps a behavioural response to EMFs. Mortality from vessel collisions is considered unlikely.	**Low** – Avoidance of vessels conducting maintenance or of EMFs is expected to fall within the normal range of behavioural variability.	**Local to Regional** – Sea Turtles may avoid the immediate area around maintenance / operation activities or avoidance may extend beyond the LSA but will be confined to the RSA.	**Short-term to Far Future** – Any effects will be limited to maintenance activities in a given year. – Any effects (albeit unlikely) from EMF could persist for the duration of operations.	**Low to Continuous** – Any effects of maintenance activities are expected to occur at most once per year. – Any effects (albeit unlikely) of EMFs could be continuous for the duration of operations.
Summary of Likely Residual Operations and Maintenance Effects on Marine Mammals and Sea Turtles: The likely residual effects of Operations and Maintenance activities on Marine Mammals and Sea Turtles are predicted to be limited to behavioural responses to noise and perhaps EMFs. Considering the known responses of these animals to vessel noise, their distribution and abundance relative to the LSAs, the results of acoustic and EMF modelling, and the mitigation proposed by Nalcor, residual effects are predicted to fall within the normal range of variability and within the RSA.					

14.3.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. Of most relevance to this Project and the Marine Mammal and Sea Turtle VEC, are the effects of underwater sound. An expert scientific committee acknowledged that current information is insufficient to predict which behavioural changes in response to anthropogenic sounds will result in significant population consequences for marine mammals (NRC 2005). The NRC (2005) did provide guidance regarding determining potentially biologically significant disruptions in important life cycle events (including migration and foraging). Based on this guidance and previous *CEAA*-compliant EA methodology, significant environmental effects on the Marine Mammals and Sea Turtles VEC for the purposes of this EIS are defined as those that affect more than 10% of the VEC within the RSA for a period exceeding one year. The inclusion of this relatively low percentage of the VEC makes the definition conservative. An environmental effect that does not meet the above criteria is not significant.

The predicted effects of Project construction, and Operations and Maintenance activities (e.g., behavioural responses to various underwater sounds and operations-related EMFs from the submarine cable and shoreline electrodes, potential temporary hearing impairment from vessel operations) will relate to much less than 10% of the Marine Mammals and Sea Turtles that occur in the RSA. In addition, Project activities that produce underwater sound will be most frequent and hence, most likely to cause behavioural effects during a six-month-period of the construction phase. During this time, Marine Mammals and Sea Turtles are predicted to exhibit localized and temporary avoidance responses that will not seriously affect migration or foraging. Therefore, the Project is not likely to result in significant adverse environmental effects on the Marine Mammals and Sea Turtles VEC.

14.3.8 Evaluation of Project Alternatives

Alternatives were considered as part of the Project design as discussed in Chapter 2, Section 2.12. No technically and economically feasible alternatives for the submarine cable crossing or the shoreline electrode sites were identified, and therefore Project alternatives are not evaluated for the Marine Environment.

14.3.9 Cumulative Environmental Effects

This section of the EIS assesses the overall effect on the Marine Mammals and Sea Turtles VEC as a result of the Project's likely residual environmental effects in combination with likely effects resulting from other projects and activities that will overlap both temporally and spatially with the Project in the RSA. The future projects and activities considered for the cumulative effects assessment included the potential future changes to the intensity / nature / distribution of fishing activity in the Strait of Belle Isle. Note, the Maritime Link listed in Table 9.3.9-2 for the Marine Environment is not considered in the cumulative effects assessment on Marine Mammals and Sea Turtles as this development does not overlap spatially with the Project and is not in proximity to the RSA, and therefore no cumulative effects are likely. Table 14.3.9-1 presents the cumulative environmental effects summary associated with the Marine Mammals and Sea Turtles VEC.

The effects of the Project in combination with other projects and activities that have been or will be carried out are not expected to affect more than 10% of the Marine Mammal and Sea Turtle VEC within the RSA for a period exceeding one year. Therefore, significant cumulative effects on the Marine Mammal and Sea Turtle VEC are not likely to occur. The planning, consultative and other effects management measures identified for this VEC will serve to avoid or reduce potential interactions and adverse effects as a result of the Project. Avoiding or managing potential effects on Marine Mammals and Sea Turtles resulting from other ongoing and future projects and activities will require that appropriate resource management, planning, regulatory and enforcement measures are in place and implemented by the relevant agencies.

Additional mitigation measures are not considered to be necessary to eliminate or reduce cumulative effects on Marine Mammals and Sea Turtles.

Table 14.3.8-1 Cumulative Environmental Effects Summary: Marine Mammals and Sea Turtles

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula [b]
Current (Baseline) VEC Condition (Reflecting the Effects of Past and Ongoing Projects and Activities)	n/a	– The current condition of the Marine Mammals and Sea Turtles VEC in the Strait of Belle Isle RSA can be described as healthy. This area is generally beyond the range of most Sea Turtles. – Past and ongoing anthropogenic projects and activities that have affected Marine Mammals and Sea Turtles in the Strait of Belle Isle RSA include vessel traffic, hunting (currently seals, historically Pinnipeds and cetaceans), and commercial fishing (by-catch).	n/a	n/a	– The current condition of the Marine Mammals and Sea Turtles VEC in the Dowden's Point RSA can be described as healthy. – Past and ongoing anthropogenic projects and activities that have affected Marine Mammals and Sea Turtles in the Dowden's Point RSA include vessel traffic (e.g., shipping, ferries, marina traffic), commercial fishing (bycatch), operation of the Holyrood Generating Station, and relatively dense human habitation in the general vicinity.
Likely Residual Environmental Effects of Labrador-Island Transmission Link (Reflecting Current VEC Condition, As Above)	n/a	– The Project will result in residual effects on marine mammal and sea turtle behaviour (primarily temporary and localized avoidance) as a result of noise and perhaps emission of EMFs.	n/a	n/a	– The Project will result in residual effects on marine mammal and sea turtle behaviour (primarily temporary and localized avoidance) as a result of noise and perhaps emission of EMFs.

Table 14.3.8-1 Cumulative Environmental Effects Summary: Marine Mammals and Sea Turtles (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle[a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula [b]
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	n/a	– All identified past and ongoing anthropogenic projects and activities have caused and will continue to cause effects on the Marine Mammals and Sea Turtles VEC in the Strait of Belle Isle RSA that overlap identified likely effects of the Project on the VEC. Effects from vessel traffic would be primarily related to behavioural responses to underwater noise. Marine Mammals and Sea Turtles may experience mortality from collisions with vessels not associated with the Project. In addition, harp and hooded seals are harvested in the RSA as part of the commercial hunt managed by Fisheries and Oceans Canada (DFO). Some Marine Mammals and possibly Sea Turtles may experience mortality as a result of fishing by-catch.	n/a	n/a	– All identified past and ongoing anthropogenic projects and activities have caused and will continue to cause effects on the Marine Mammals and Sea Turtles VEC in the Dowden's Point RSA that overlap identified effects of the Project on the VEC. Effects from vessel traffic would be primarily related to behavioural responses to underwater noise.
Cumulative Environmental Effects Summary [c]	n/a	**Not Significant** – The cumulative effect of likely Project effects that overlap both temporally and geographically with other past, present and reasonably foreseeable projects and activities is not likely to be significant.	n/a	n/a	**Not Significant** – The cumulative effect of likely Project effects that overlap both temporally and geographically with other past, present and reasonably foreseeable projects and activities is not likely to be significant.

(a) Marine environment. Applicable to the Marine VECs only.
(b) For the Marine VECs, this area comprises the Island of Newfoundland electrode site only.
(c) Total (cumulative) change from the existing environment. Significance of cumulative effects evaluated using same definitions as for the Project Environmental Effects Analysis.

14.3.10 Monitoring and Follow-up

A follow-up program will be conducted by Nalcor to evaluate the EMFs that will be generated by the operating submarine cable and electrodes. This program would provide *in situ* gradient-to-background electromagnetic measurements at varying distances from the sources. These follow-up activities will further reduce uncertainty concerning the predicted effects of the electrodes and cable operations, and will provide information that will be considered in Nalcor's adaptive management process as appropriate.

14.4 Seabirds

14.4.1 Introduction

Seabirds are defined here as those species that use marine waters, including the intertidal zone, for foraging, resting or migrating. These seabirds come from a variety of bird taxonomic groups and include geese and ducks, loons, fulmars and shearwaters, storm-petrels, Northern Gannet, cormorants, plovers, sandpipers and phalaropes, skuas and jaegers, gulls and terns, murres, razorbill, guillemots, puffins and Dovekie (collectively called auks or alcids). Seabird species are often grouped into three categories based on the water depth they prefer. Some seabird species are usually found in waters greater than 50 m in depth even while on foraging trips during the nesting season. Because of this habitat preference these species are collectively referred to as "pelagic seabirds". Other species spend most of their time in waters 50 m deep or shallower and are referred to as "coastal waterbirds". Many species of plovers and sandpipers forage in the intertidal zone and are referred to as "shorebirds".

Newfoundland, Labrador, Quebec, Nunavut and Greenland all support populations of seabirds that are globally significant in size, and that nest, forage, stage or winter in the Strait of Belle Isle and Conception Bay. Most species of the Seabird VEC have stable population sizes or are slowly increasing or decreasing (Gaston et al. 2009; Goulet and Robertson 2007). Razorbill nesting on Gannet Islands may be declining in number due to hunting (Lavers et al. 2009). Ivory Gull numbers are declining rapidly (Gilchrist and Mallory 2005). These seabirds have social, cultural, economic, aesthetic, ecological and scientific importance. Occupying positions at or near the top of the food chain, they are an important resource for tourism, hunting, bird watching and scientific study. Seabirds are highly visible and, as such, are of prime public and scientific concern at local, national and international scales.

Pelagic seabirds of the fulmars and shearwaters (Procellariidae), storm-petrels (Hydrobatidae), Northern Gannet (Sulidae) and auks (Alcidae) have low annual recruitment rates and high annual adult-survival rates, so their populations are sensitive to changes in adult mortality. Many seabird species concentrate in colonies for nesting. As a result, their populations are sensitive to disturbances to colonies or to areas where they forage to provision their young. As a result of these factors, seabird populations in general have low resilience to environmental change.

Small numbers of at risk Harlequin Duck, Barrow's Goldeneye and Red Knot (COSEWIC 2010, internet site) use the Strait of Belle Isle and Conception Bay in passage between breeding and wintering areas. Small numbers of the endangered Ivory Gull (COSEWIC 2010, internet site) occasionally use these areas in winter.

14.4.2 Environmental Assessment Study Areas

14.4.2.1 Spatial Boundaries

The Local Study Area (LSA) is comprised of three components: (i) the submarine cable crossing corridor in the Strait of Belle Isle (Corridor LSA Component) (Figure 14.4.2-1); (ii) the two marine areas defined by arcs of 500 m radius from the proposed shoreline electrode sites at L'Anse au Diable (L'Anse au Diable LSA Component) (Figure 14.4.2-1 in the Strait of Belle Isle and (iii) Dowden's Point (Dowden's Point LSA Component) (Figure 14.4.2-2) in Conception Bay. The Corridor LSA Component includes the terrestrial landing sites for the submarine cable (Figure 14.4.2-1).

The Regional Study Area (RSA) reflects the likely maximum areal extent of the relevant foraging areas for seabirds addressed in this VEC. Nesting Seabirds, especially colonially nesting species, are limited by suitable nesting habitat. In addition, their food resources are patchy and ephemeral. As a result, Nesting Seabirds often travel many kilometres (km) during a given foraging sortie to provision their nestlings. The Strait of Belle Isle RSA for the submarine cable crossing corridor and the L'Anse au Diable shoreline electrode site are comprised of the Strait of Belle Isle as well as that part of the Gulf of St. Lawrence almost as far west as Saint Augustin, Québec, and Port au Choix, Newfoundland, and extends to St. Peter's Head, Labrador, and slightly beyond L'Anse aux Meadows, Newfoundland (see Figure 14.4.2-1). The Conception Bay RSA consists of Conception Bay as well as Grates Point, Baccalieu Island and Cape St. Francis Important Bird Areas (see Figure 14.4.2-2).

14.4.2.2 Temporal Boundaries

The temporal boundaries for the EA encompass a four-year period for the Project Construction phase, and an indefinite period for the Project Operations and Maintenance phase.

14.4.3 Potential Environmental Issues, Indicators and Interactions

14.4.3.1 Potential Environmental Issues

No issues regarding Project effects on Seabirds were identified through the consultation process. However, the EIS study team identified three potential issues: (i) anthropogenic noise, (ii) presence of vessels, vehicles and people, (iii) artificial lighting, and (iv) operation of the shoreline electrodes.

Anthropogenic noise and visual stimuli may disturb Seabirds. Such issues arising from construction activities at the submarine cable crossing corridor, drilling sites and electrode sites may disrupt behaviour of seabirds using shallow waters, intertidal areas and coastal heathlands in the Corridor LSA Component (submarine cable landing sites), L'Anse au Diable LSA Component and Dowden's Point LSA Component (Table 14.4.3-1). Anthropogenic noise and visual stimuli from construction may disrupt autumn migrant shorebird foraging or resting in the intertidal areas of coves, or in coastal heathlands at or near the drilling and electrode sites. During the breeding season, these stimuli may also disrupt courtship, nest construction, egg laying, incubating and provisioning of nestlings at a small, tern nesting colony in Shoal Cove (Corridor LSA Component) and individual nests of shorebirds or Black Guillemot at in the vicinity of the drilling and electrode sites. Anthropogenic activity may also disrupt Seabirds feeding in the LSA Components to provision their nestlings at colonies elsewhere in the Strait of Belle Isle and Conception Bay RSAs.

Artificial lighting on vessels used during construction of the submarine cables may disrupt behaviour of nocturnally-active seabirds, especially Leach's Storm-Petrel, a pelagic seabird. During dark nights, such lighting may attract storm-petrels and other species to vessels where they may collide with or strand onboard such vessels, causing mortality (Table 14.4.3-1).

The study team also considered the potential for the electric field and electromagnetic field (EMF) created by the shoreline electrodes to affect birds that land within the saltwater pond, either from a navigational perspective or the potential for electrical shock (Table 14.4.3-1).

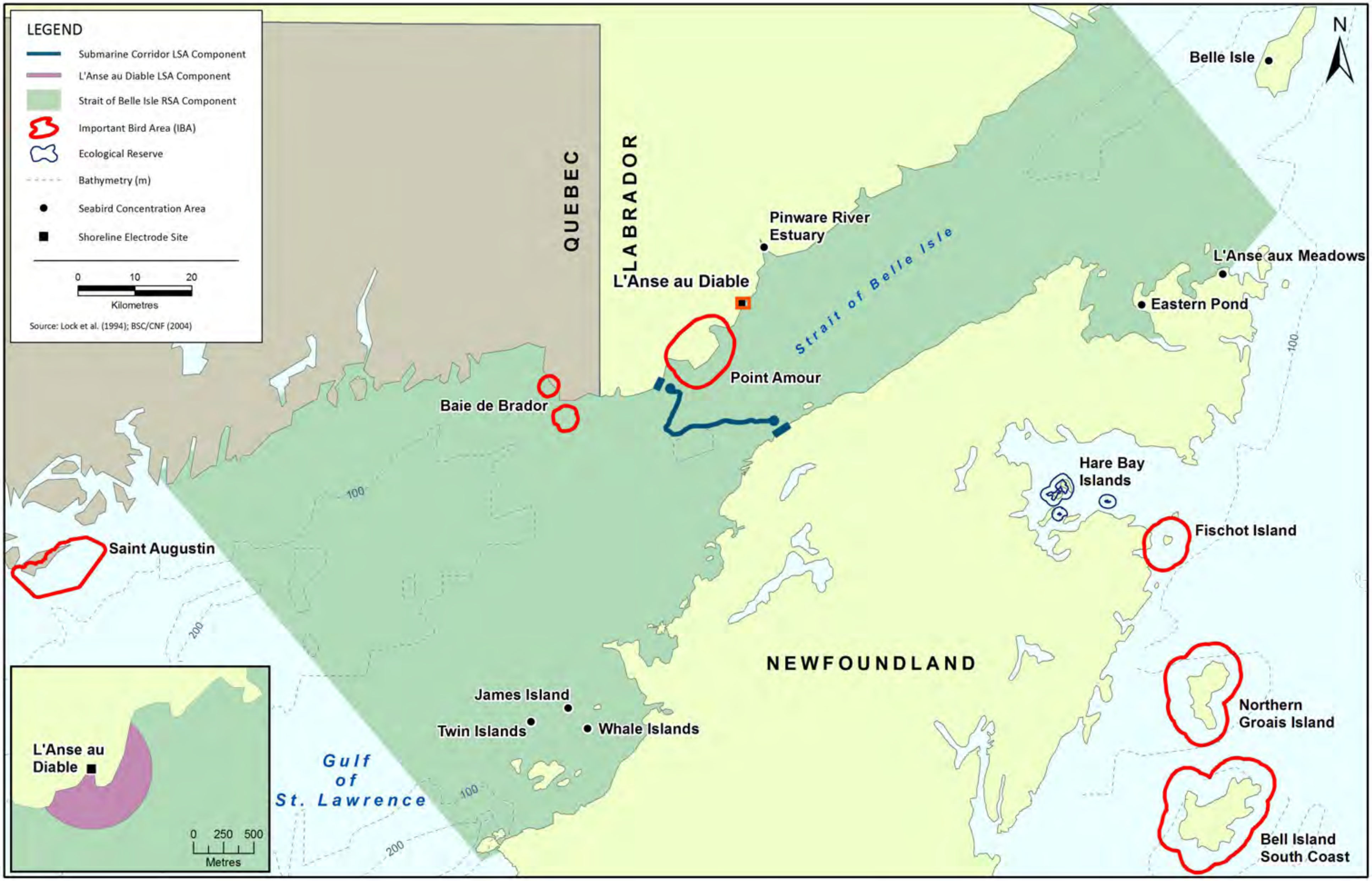
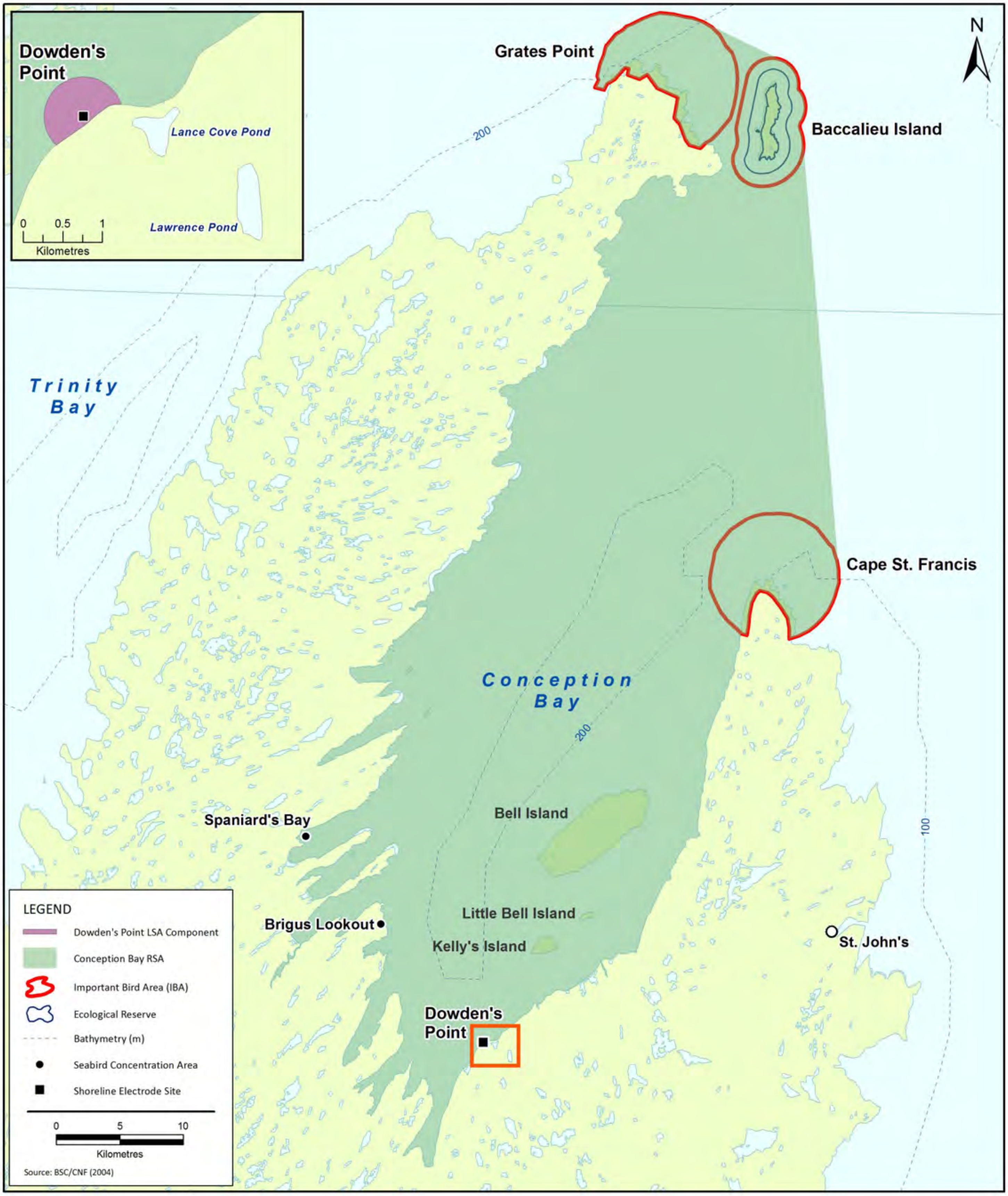


FIGURE 14.4.2-1

Seabird Local Study Area (LSA) and Regional Study Area (RSA) Components in the Strait of Belle Isle Area



nalcor energy

FIGURE 14.4.2-2

Seabird Local Study Area (LSA) and Regional Study Area (RSA) Components in Conception Bay, Newfoundland

Table 14.4.3-1 Identified Issues and Questions: Seabird VEC

Issue / Question	Nature and Rationale	Specific Considerations
Noise	Disturbance from cable-laying, drilling operations or electrode construction may disrupt Seabird courtship, nest construction, laying, incubating, foraging, provisioning or resting	Shorebirds and Red Knot *rufa* subspecies (endangered – *NLESA* and COSEWIC) from July to November in intertidal zone in coves and in coastal heathlands; tern colony on an island in Shoal Cove; pelagic and coastal waterbirds foraging to provision nestlings; Corridor LSA Component (submarine cable landing sites), L'Anse au Diable LSA Component and Dowden's Point LSA Component
Presence of vessels, vehicles and people	Disturbance from drilling operations or electrode construction may disrupt Seabird laying, incubating, foraging, provisioning or resting	Shorebirds and Red Knot *rufa* subspecies (endangered – *NLESA* and COSEWIC) from July to November in intertidal zone in coves and in coastal heathlands; tern colony on an island in Shoal Cove; pelagic and coastal waterbirds foraging to provision nestlings; Corridor LSA Component, L'Anse au Diable LSA Component and Dowden's Point LSA Component
Artificial lighting	Attraction of Seabirds to Project vessels could cause collision or stranding	Leach's Storm-Petrel on nights with fog, rain or low moonlight levels, June to November, especially September and October; Corridor LSA Component, L'Anse au Diable LSA Component and Dowden's Point LSA Component
Electrode operation	Seabirds coming into contact with the electrode saltwater pond may have navigation affected by the electromagnetic field, or may be electrocuted by the electric field	Shorebird or swimming Seabirds would have to come in contact with electrode saltwater pond water and surrounding bank simultaneously

14.4.3.2 Key Indicators and Measurable Parameters

The three KIs of the Seabird VEC chosen for this effects assessment are representative of the Seabird VEC's trophic, temporal and spatial distribution in the LSA and RSA, and can provide an assessment that responds to the potential environmental issues identified. These KIs are also representative of this VEC's social, cultural, economic, aesthetic, ecological and scientific importance. The KIs chosen are: (i) Migrating Shorebirds; (ii) Nesting Seabirds (especially colonially-nesting species); and (iii) At-sea (away from nest) Seabirds (see Table 14.4.3-2).

Migrating Shorebirds are present in the LSA Components and RSAs offshore during July to November, and in the intertidal zone and coastal heathlands when foraging and resting. They are sensitive to habitat perturbations because they concentrate at foraging and resting sites. The effects of the Project such as disturbance on abundance are measurable by sampling at breeding areas and staging areas during migration. Effects of disturbance on the use of important habitats are measurable through counts at and presence / absence at these habitat areas. Effects of disturbance on behaviour are measurable through the relative amounts of time spent foraging and resting.

Nesting Seabirds are present in the L'Anse au Diable LSA Component, Corridor LSA Component and RSA during May to October and in Conception Bay in the Dowden's Point LSA Component and RSA during April to November. The disturbance effects of the Project on abundance are measurable through aerial counts of the numbers of breeding pairs at nesting colonies and counts of individuals concentrated at spawning areas of pelagic fish. Information in the Community-based Coastal Resource Inventory (CCRI) Database suggests that pelagic fish (capelin) spawn in inshore waters in the vicinity of the L'Anse au Diable electrode site in the Strait of Belle Isle (Sikumiut 2010a). It is important to note that much of the information contained in these inventories is derived from local ecological knowledge, collected through interviews, and therefore considered anecdotal in nature, thus the exact location of capelin spawning for example, is not geo-referenced.

Seabirds are present at-sea in the LSA and RSA during the ice-free season, and in leads in the ice during winter. At various times of the year, some species of pelagic seabirds, coastal waterbirds and shorebirds are foraging in the LSA, migrating through the LSA or commuting through the LSA between nests and foraging areas. The effects of direct mortality from collision with or stranding on Project vessels are measurable through onboard monitoring of local abundance, local distribution and behaviour.

The KIs and their nests are protected from harassment, injury or destruction by the federal *Migratory Birds Convention Act*, with the exception of cormorants (part of the Nesting Seabird KI and At-sea Seabird KI) (Canadian Wildlife Service 1991). The Migrating Shorebirds KI includes Red Knot *rufa* subspecies, which is protected by the *NLESA*. The At-sea Seabirds KI includes the Harlequin Duck eastern population, Barrow's Goldeneye eastern population and Ivory Gull, which are also protected by the *NLESA* and the *SARA*.

The Nesting Seabirds and At-sea Seabirds KIs include pelagic seabirds. Some pelagic species' populations are sensitive because of their position in the food chain. These KIs include Atlantic Puffin, a species of cultural importance because of its status as the provincial bird symbol of Newfoundland and Labrador. The puffin is also a species of economic importance because of its value to the tourism industry. These KIs also include eiders and murres, which are of importance to the subsistence economy as well as the commercial economy because of the money spent on equipment and fuel to harvest these species. The KIs include species that have high visibility and are thus relatively easy to study. As a result, data are available on potential Project effects such as disturbance and direct mortality.

Table 14.4.3-2 Key Indicators and Associated Measurable Parameters: Seabirds

Key Indicator	Rationale for Key Indicator	Measurable Parameter	Rationale for Measurable Parameter
Migrating Shorebirds	Individuals foraging or resting at or near drill sites and electrode sites potentially affected by onshore Project activities	– Change in abundance – Change in habitat use – Change in behaviour	Visual or aural stimuli may disturb shorebirds, thereby restricting access to food supplies or roosting sites[(a)]
Nesting Seabirds (colonially- and solitarily-nesting species)	Incubating, foraging or provisioning individuals offshore from drill and electrode sites potentially affected by onshore Project activities; small tern colony in Shoal Cove, birds from colonies elsewhere in the RSA may forage in the L'Anse au Diable LSA Component and the Corridor LSA Component	– Change in abundance – Change in distribution – Change in nesting success rate – Change in behaviour	Visual or aural stimuli may disturb seabirds at a nesting colony, or disturb seabirds at foraging sites thereby restricting access to food supplies, such as spawning pelagic fish species; this may affect local Seabird abundance and ultimately reproductive success[(b)]
At-sea Seabirds	Foraging, commuting or migrating individuals offshore potentially affected by Project vessels	– Change in abundance – Change in distribution – Change in behaviour	Project activities (e.g., waste disposal, artificial lighting, etc.) may attract, or vessels may obstruct flying birds resulting in collision or stranding mortality[(c)]

(a) Tarr et al. (2010).
(b) Nettleship (1980).
(c) Miles et al. (2010); Merkel (2010).

14.4.3.3 Potential Project-Seabirds Interactions

The activities required for Project Construction, and Operations and Maintenance phases have the potential to interact with the Seabird VEC (Table 14.4.3-3). During the Construction phase, preparation and construction of submarine cable landing sites (on-land works) may disturb Migrating Shorebirds in nearby intertidal areas or coastal heathlands, resulting in interruption of foraging or resting. Construction and installation of submarine cables may interact with Migrating Shorebirds, Nesting Seabirds or At-sea Seabirds that are foraging, migrating or commuting between nests and feeding areas. Flying seabirds may collide with Project vessels, or become attracted by vessel lighting and collide with or strand on vessels. Electrode site preparation and installation may interact with Seabirds through habitat alteration / loss or disturbance. Intertidal shorebird (migrant) habitat or shallow-water foraging areas of nesting birds may be replaced by electrode site infrastructure. If an electrode site saltwater pond is constructed by excavation from land, construction activities and noise may disturb foraging or resting shorebirds or Nesting Seabirds that are feeding inshore on pelagic fish spawning in the shallows.

The Operations and Maintenance phase of the Project may interact with At-sea Seabirds. During routine line inspections and repairs of the submarine cable, and during major system repairs of the submarine cable, vessels will be used. This activity has the potential for Seabirds colliding with or being attracted to artificial lighting with the potential of stranding on Project vessels. If Seabirds land on or wade in the electrode saltwater ponds, the electric and magnetic fields generated by the electrodes may have effects on those birds.

Table 14.4.3-3 Potential Project Interactions: Seabirds

Project Component / Activity	Key Indicator		
	Migrating Shorebirds	**Nesting Seabirds**	**At-sea Seabirds**
Construction			
Construction of access trails and roads	—	—	—
Movement and presence of personnel, equipment and materials			
Construction camps			
Marshalling yards and staging areas			
Right-of-way clearing and preparation			
Quarrying and burrowing			
Transmission tower assembly and installation			
Conductor installation			
Converter station site preparation and construction			
Preparation and construction of submarine cable landing sites (on-land works)	– Disturbance from human activity, noise restricting access to habitat (intertidal zone or coastal heathlands)	– Disturbance from human activity, noise restricting access to nearshore spawning areas of pelagic fish species for foraging	– Strandings on land caused by light attraction; collisions with drilling equipment
Construction and installation of submarine cables (Marine works)	—	—	– Strandings on vessels caused by light attraction; collisions with vessels
Electrode site preparation and installation	– Disturbance from human activity, noise restricting access to habitat (intertidal zone or coastal heathlands) – Direct loss of habitat	– Disturbance from human activity, noise restricting access to habitat (inshore) – Direct loss of habitat	—

Table 14.4.3-3 Potential Project Interactions: Seabirds (continued)

Project Component / Activity	Key Indicator		
	Migrating Shorebirds	**Nesting Seabirds**	**At-sea Seabirds**
Island system upgrades	—	—	—
Employment / presence of workers			
Contracting / expenditures			
System commissioning			
Operations and Maintenance			
Operations / Maintenance access trails and roads	—	—	—
Presence and Operation of the transmission system			
Routine line inspections and repairs			– Strandings on vessels caused by light attraction – collisions with vessels
Vegetation management			—
Potential major system repairs	– Disturbance from human activity, noise restricting access to habitat (intertidal zone or coastal heathlands)	– Disturbance from human activity, noise restricting access to habitat (inshore)	– Vessel strandings caused by light attraction – Collisions with vessels
Operation of the electrodes	– Change in behaviour, depart the location of the saltwater ponds	– Change in behaviour, depart the location of the saltwater ponds	– Change in behaviour, depart the location of the saltwater ponds
Employment / presence of workers	—	—	—
Contracting / expenditures			

— No likely or detectable interaction identified.

14.4.4 Approach to the Environmental Effects Analysis

14.4.4.1 Analytical Methods

Baseline conditions for the Seabird VEC were established by examining data from the *Avifauna Component Study* (Stantec 2010a), the *Marine Mammals, Sea Turtles and Seabirds in the Strait of Belle Isle: Supplementary Information Review and Compilation* (Sikumiut 2010b), compilations of existing literature about the study areas, seabird population databases and consultation with Canadian Wildlife Service biologists. The literature was also reviewed to determine how Seabirds respond to activities similar to those that will occur during the Project.

The analysis considers the nature and degree of Project-induced change from the existing environment (baseline conditions). The activities and locations of the Project components are compared with the location and timing of known concentrations of Seabirds to determine the potential for effects. When data are insufficient to allow certain or precise effects evaluations, predictions are made based on professional judgement.

Information on the effects of anthropogenic noise and disturbance on seabirds is derived from the existing literature. There are no studies of the noise and disturbance effects identical to those likely resulting from the Project on those seabird species potentially affected by the Project and in the habitats and areas affected by the Project. In the absence of quantitative information, the existing literature provides qualitative information that is used to assess Project effects on this VEC.

The component studies *Labrador – Island Transmission Link: Marine Water, Sediment, Benthos and Nearshore Habitat Surveys – Potential Electrode Sites* (Sikumiut 2011a) and *2011 Marine Habitat and Water, Sediment and Benthic Survey: Strait of Belle Isle Cable Corridor Segment - Shoal Cove Option* (Sikumiut 2011c) provide quantitative data on organic content and fauna of the intertidal sediment, i.e., shorebird feeding habitat. However, there are no quantitative data on habitat requirements of the shorebird species in this area or the potential effects of restricted access to or loss of this habitat on individual shorebirds or populations of these species.

The existing literature on the effects of seabird attraction by artificial lighting is descriptive and these data are specific to site, vessel lighting characteristics, season and species. As a result, the available literature does not provide quantitative data on effects of Project artificial lighting. However, the literature does provide qualitative information that is used to assess the effects of artificial lighting from the Project on Seabirds. Acoustic, electric field, and EMF modelling were conducted by Nalcor and these provide quantitative information used to assess Project effects on Seabirds. The results of the modelling were compared with relevant literature to assess the effects.

Sound Modelling

Estimates of sound emissions and corresponding sound pressure levels from equipment and activities associated with the preparation and construction of submarine cable landing sites were used to assess potential environmental effects from construction (see Chapter 11). Predictions of representative sound pressure levels resulting from the construction of the Project were then made using the CadnaA model (Computer Aided Noise Abatement, version 4), based on the sound power levels. The CadnaA model is a recognized sound attenuation model and is in full compliance with the predictive methods of International Organizations for Standardization (ISO) ISO 9613-1 and ISO 9613-2 (ISO 1996, 1993). The CadnaA noise model accounts for the distance, atmospheric, and ground attenuation, screening effects of surrounding terrain and meteorological conditions.

Electric Field Modelling

The electric field created by the electrodes is a function of the Ground Potential Rise (GPR) gradient. The GPR gradient model uses two inputs to model the difference in voltage predicted at various distances from the electrode site: (i) the resistivity (i.e., how strongly a material opposes the flow of electric current) of the geological units and of the seawater surrounding the electrode; and (ii) the electrode current at nominal levels during normal bipolar operations (e.g., < 1% of the current) and during monopolar operations (e.g., 100% of the current). Hatch Ltd. (2011) modelled the GPR gradient at various distances from the electrode to determine the electric field produced under normal bipolar operations and during monopolar operations.

Electromagnetic Field Modelling

Magnetic fields are produced by the flow of current through cables and conductors, and also as electric current passes through other media such as the sea and soil. The magnitude of the magnetic field at a given point is dependent on the distance from the conductor, and the permeability of the medium. Hatch Ltd. (2011) modelled the magnetic field for both electrode sites for electrode current at nominal levels during normal bipolar operations (e.g., < 1% of the current) and during monopolar operations (e.g., 100% of the current). The magnetic field modelling is based on the GPR gradient model used for the electric field modelling. The magnetic field modelling was calculated at the surface as this represents the worst-case for EMFs, as it decreases with depth.

During the assessment process, appropriate mitigation measures are identified to minimize the effects that could result from the interactions between Project activities and the Seabirds VEC. The effects assessment is based on the Project activities with mitigation in place.

14.4.4.2 Environmental Effects Descriptors

Five descriptors are used to assess the residual effects of the Project on the KIs of the Seabirds VEC: (i) direction; (ii) magnitude; (iii) geographic extent; (iv) duration; and (v) frequency. Each descriptor is characterized by at least three ratings that provide further clarification of the descriptor of any particular residual effect. The definitions of the ratings of environmental residual effects descriptors for the KIs of the Seabirds VEC are provided in Table 14.4.4-1. The definitions apply to all three KIs of this VEC.

Table 14.4.4-1 Effects Descriptors: Seabirds

Effects Descriptor	Definition
Direction	
Adverse	Undesirable effect on KI
Neutral	No effect on KI
Beneficial	Desirable effect on KI
Magnitude	
Low	Effect on KI within normal range of variability
Moderate	Effect on KI unlikely to pose serious risk to the VEC or represent management challenge
High	Effect on KI likely to pose serious risk to the VEC and represent management challenge
Geographic Extent	
Local	Effect on KI limited to the Local Study Area
Regional	Effect on KI limited to the Regional Study Area
Beyond regional	Effect on KI extends beyond the Regional Study Area
Duration	
Short-term	Effect on KI persists for ≤1 year
Medium-term	Effect on KI persists for >1 to ≤4 years
Long-term	Effect on KI persists for >4 to ≤30 years
Far future	Effect on KI persists for >30 years
Frequency	
Low	Effect on KI occurs not more than once per year
Moderate	Effect on KI occurs 2 to 10 times per year
High	Effect on KI occurs more than 10 times per year
Continuous	Effect on KI is continuous

14.4.5 Construction

14.4.5.1 Overview of Project Construction and Associated Effects Management

At the submarine cable landing sites, the presence of and noise from equipment and humans used to level and remove overburden for the drill rig, general equipment staging and work space, and from drilling and associated activities, have the potential to disturb shorebirds foraging or resting in the intertidal zone and coastal heathlands and pelagic and coastal waterbirds foraging inshore (e.g., on spawning pelagic species of fish). Three boreholes (i.e., one per cable) will be drilled in sequence for the shore approaches at Forteau Point and Shoal Cove. It is expected that the HDD process will take place 24 hours a day, seven days a week and it is expected to take approximately 2.5 years to complete the three boreholes at Shoal Cove and approximately 2 years at Forteau Point. Two drill rigs will operate concurrently, one at Forteau Point and the other at Shoal Cove.

During the electrode site construction, the construction of berms may disturb shorebirds foraging or resting in the intertidal zone and coastal heathlands and pelagic and coastal waterbirds foraging inshore. This construction is expected to alter a small area of intertidal zone habitat. In Option 2 of the Dowden's Point electrode, excavation of the channel may result in similar disturbance and affect a small area of intertidal zone habitat.

Construction and installation of the submarine cables may disturb seabirds through the presence and noise generated by Project vessels. Seabird species that must fly rapidly because of high wing loadings (alcids such as Razorbill and sea ducks such as eiders) have poor manoeuvrability. Such species may collide with vessels when visibility is poor. At night, artificial lighting onboard Project vessels may attract Leach's Storm-Petrel or other seabird species, resulting in stranding or mortality.

Mitigation measures to avoid or limit Project effects of Construction on the Seabirds VEC include:

- construction time will be minimized to decrease the amount of interaction with Seabirds;
- Project construction equipment will be maintained to ensure that noise control devices such as engine mufflers are working to specification;
- vessels will be outfitted, operated and maintained to limit the potential for inadvertent releases of contaminants (e.g., oil) including proper protocols will be implemented to avoid accidental introduction of potentially deleterious substances to the marine environment including all applicable regulations to minimize effect on seawater;
- biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies;
- spill kits and trained personnel will be present on-site at all times, allowing for prompt containment;
- a spill response team will be formed and trained;
- spills will be reported to the appropriate authority;
- fuelling or serving or mobile equipment on-land will not be permitted within 50 m of a waterbody
- the SHERP (Safety, Health and Environment Emergency Response Plan) will contain spill prevention and response plan;
- the EPP (Environmental Protection Plan) will contain conditions for fuel handling and storage, including procedures for spill response;
- daily monitoring will be conducted of Seabird stranding through searches of decks, and recovering and releasing stranded birds to the sea;

- lighting will be reduced, and shielded from pointing skyward to reduce light attraction to the extent practical and feasible (i.e., without compromising work and vessel safety); and
- the size of the electrode sites will be limited to that required to safely and efficiently construct the system.

14.4.5.2 Existing Knowledge

Information on the effects of construction of submarine electrical transmission projects on Seabird abundance, habitat use, behaviour, distribution or nesting success was inferred from similar types of projects where appropriate.

14.4.5.3 Construction Effects: Migrating Shorebirds

Disturbance and Noise

The effects of noise and disturbance on wildlife is a broad subject ranging from effects on physiology and / or behaviour of the individual animal, through to consequences of noise to populations, to alterations of the communities, landscapes and ecoregions by affecting reproductive success of wildlife species or excluding wildlife species from those areas. Disturbance is one of the most important of the anthropogenic stressors (Nisbet 2000, 1977). Effects of disturbance are any consequence of this anthropogenic influence, and are not necessarily biologically significant or even negative (Bowles et al. 1991).

Noise disturbance may cause stress in animals and this has physiological implications in wildlife (Wasser et al. 1997; Westman and Walters 1981; Siegel 1980; Welch and Welch 1970; Selye 1976, 1950). Noise disturbance stimulates the auditory senses of wildlife, and effects originate from acoustical stimulation of the neuro-physiological system in animals (Welch and Welch 1970). The resulting stress manifests itself as behavioural responses that range from mild annoyance to panic and escape behaviour. Excessive stimulation of the nervous system can amount to chronic stress, and this has implications to health, growth and reproductive fitness of animals (Fletcher 1980; Fletcher and Busnel 1978).

Noise can be broadly classified into three categories: (i) continuous noise; (ii) impulse noise; and (iii) impact noise. Continuous noise is seldom encountered by wildlife except when adjacent to human activities. Impulse noise and continuous noise differ both in their potential physical effects, namely hearing damage, and in their sensory-mediated physiological and behavioural effects (Roberto et al. 1985). Animals habituate poorly to high amplitude noise with rapid onset (Korn and Moyer 1966).

Hearing damage from loud noise is a result of physiological change to the auditory system, notably loss or damage to hair cells in the cochlea. Hearing loss or damage can be produced by brief exposure to very loud sound or by prolonged exposure to moderate levels of sound. Animals vary greatly in their sensitivities and susceptibilities to hearing loss. The frequency content of sound is important because sounds of different spectra affect the auditory system differently. For example, high frequency tones tend to produce localized changes in the inner ear, whereas low frequency tones tend to produce changes throughout the length of the cochleae (Fletcher and Busnel 1978).

Disturbance Effects

When confronted with disturbance, an animal may respond in three ways: (i) choose a behavioural response, and / or it may evoke the (ii) autonomic and / or (iii) neuroendocrine systems. The responses of the latter systems result in changes in biological function, i.e., diverting the animals own resources from ongoing biological activities to new biological activities that may assist the animal in coping with the stressor (Moberg 1987, 1985). Reflexes may be weakened and learning responses decreased through chronic exposure to harmful noise levels. There is close correlation between behavioural responses and physiological measures (Bowles et al. 1991; Thiessen and Shaw 1957).

The behavioural effects of disturbance on birds are highly variable, and can be categorized as follows:

- **Avoidance** – animals can avoid disturbances (especially noise), and this can involve abandonment of preferred habitat, change in home ranges, and / or altered migration patterns, and may confer a decrease in survival;
- **Adaptive habituation** – in some cases wildlife may demonstrate no response or may habituate or adapt to human disturbance; and
- **Attraction** – in certain cases, wildlife may be attracted to the disturbances such as vehicles and traffic, lights (e.g., raptors and small mammals attracted to airport runways possibly because of availability of food; Informatics 1980).

The lack of behavioural responses to disturbances do not necessarily mean that animals are not stressed by stimuli because physiological changes may still occur even when no outward behavioural change is apparent (e.g., Goudie 2006; Gill et al. 2000; Conomy et al. 1998; Temple et al. 1996; Jungius and Hirsch 1979).

Many studies of the effects of human disturbance on breeding success of individuals show detectable results (Reijnen and Foppen 1994; Hockin et al. 1992). In areas of bird concentrations, such as seabird colonies, human disturbance can cause mass loss of eggs and / or young affecting the reproductive output of the entire colony (Manuwal 1978). However, few studies have quantified reactions of animals or their young to disturbance, and few quantified the mechanisms by which reproductive success was affected.

The main reasons postulated for lower breeding success in birds subjected to human disturbances are:

- nest abandonment (Anderson 1988; Anderson and Keith 1980);
- increased predation of eggs and young (Titus and van Druff 1981);
- direct destruction of nests (Burger 1991);
- deferment of breeding (Hobson and Hallinan 1981; Tremblay and Ellison 1979);
- exposure of eggs (Hunt 1972);
- inhibiting effects on female maternal behaviour (broodiness) (Jeannoutot and Adams 1961);
- reduced feeding and brooding of young and increased mortality (Flemming et al. 1988); and
- accidental collisions (Safina and Burger 1983; Blokpoel and Hatch 1976).

Disturbance generally reduces feeding time and increases energetically costly behaviours, notably flying (Belanger and Bedard 1990, 1989; Owens 1977), and overall daily energy expenditure can increase significantly (e.g., 20% in Watmough 1983; 31% in White-Robinson 1982). Such stress is thought to confer a survival cost to individuals, and increased mortality within populations.

The effects of disturbance on behaviour could make certain feeding sites undesirable to birds because of a poor net gain of energy and therefore of fat tissues. Disturbance may affect body condition, subsequent reproductive output and / or parental care (Fernandez and Azkona 1993).

Effects on survival rates, emigration rates and / or breeding success of individuals may affect populations. Disturbances can reduce populations of birds in certain geographic areas or zones of disturbance (Reijnen and Foppen 1994).

Disturbance may lower carrying capacity of habitat for birds leading to lower densities in zones affected by disturbances (Madsen 1994; Reijnen and Foppen 1994). Alternatively, disturbance may result in wildlife such as shorebirds feeding in poorer quality habitats, and feeding below the threshold rate required for survival rates sufficient to maintain populations over the longer term. This leads to rises in the proportion of birds dying or emigrating as population size increases, i.e., a density dependent effect (Gill et al. 1996; Goss-Custard et al. 1995).

Disturbance may cause redistribution of wildlife. If animals are displaced from a site, their survival depends on the availability of alternate feeding sites. Displaced individual animals, such as shorebirds and songbirds, may suffer from mutual interference when forced to feed elsewhere under increased densities thereby affecting food intake rate which, if repeated, could affect carrying capacity leading to metapopulation effects and subsequently population effects (Goss-Custard et al. 1995; Sutherland and Anderson 1993).

Disturbance is most likely to have an effect during the periods of the annual life cycle when food resources are depleted and birds have difficulty in meeting daily energy requirements (e.g., fall migration in shorebirds, Goss-Custard et al. 1995; or winter in waterfowl, Madsen 1994). Such periods probably occur when individuals need to build up nutrient reserves in advance of periods of high energetic demand, such as breeding or migration.

Hearing Abilities in Birds

Similar to humans, birds are most sensitive to sounds ranging from approximately 1 kHz to 4 kHz with sensitivity decreasing at lower and higher frequencies. For this reason, birds are more likely to respond to mid-frequency noise. Birds possess a highly evolved auditory system and sensitive hearing, and vocal communication plays an important role in many species. There is a steep increase in the hearing sensitivity threshold from 4 kHz up to 10 kHz, which is the upper limit in most species. In specialized species of birds the upper threshold approaches 20 kHz. (Meyer 1986).

Similar to humans and other mammals, birds discriminate frequency differences and sound intensities. Because of the small head of most birds, sound attenuation between ears is small, and this is important for sound localization (Necker 2000; Dooling 2000, 1980). Sounds separated by a time interval are recognized as separate if the interval exceeds 2 to 10 msec (Wilkerson and Howse 1975). Most birds are able to localize sound in the azimuth (horizontal plane) but not in elevation (Knudson 1980). Noise varies with disturbance type, and typically there is a threshold in amplitude beyond which response increases markedly (Goudie and Jones 2004; Pater 2001). Responses by birds to noise vary among species (Ryals et al. 1999).

Disturbance, Noise and Seabirds

Most of the studies of the effects of disturbance and noise on Seabirds have been conducted on non-consumptive recreational activities or on fishing or hunting activities. There are no studies of the effects of disturbance and noise on Seabirds from construction of submarine electrical transmission lines.

Although the sources of disturbance to Seabirds vary, the effects they have on Seabirds are similar: they exclude birds from feeding or roosting areas, increase energy demands by causing birds to take flight or to reduce feeding time, decrease feeding efficiency, force birds to spend more time being vigilant or to increase their metabolic rate before taking flight (Peters and Otis 2007; Burger and Gochfeld 1991). For example, vehicle disturbance of shorebirds staging during migration (North Carolina) results in a decrease in total shorebird abundance of 58% (Tarr et al. 2010). Black-bellied plover, Willet and Sanderling use of some habitats decreases in response to vehicle disturbance (Tarr et al. 2010). Sanderling time spent resting also decreases whereas the time spent active increases in response to vehicle disturbance (Tarr et al. 2010). Pfister et al. (1992) also found a negative correlation between staging Sanderling abundance and vehicle numbers (in Massachusetts).

In response to human pedestrian traffic, staging and wintering Sanderlings reduce their time spent foraging (California), and they respond to human pedestrian disturbance at distances of <100 m (Thomas et al. 2003). The effects of disturbance by fast boats on foraging on Common Eider and other coastal waterbird species include reductions in diurnal foraging activity by up to 60% and increases in nocturnal foraging (south-west Greenland) (Merkel et al. 2009). Disturbances occurring at distances of less than 1 km or more frequently than once per hour have a cumulative effect (Merkel et al. 2009). However, the effects of noise and disturbance are specific to the noise, visual disturbance, site, context and species, so these studies provide data for qualitative comparisons only.

Effects of Project Activities

Submarine cable landing site preparation and construction (on-land works) will involve the movement of heavy machinery and humans with associated noise. Drilling at Shoal Cove is scheduled to take approximately 2.5 years and at Forteau Point it will take approximately two years. During this time drilling will take place 24 hours per day, seven days per week. The sound pressure levels of a typical drill rig with a sound power level of 115 dBA (as calculated from the sound pressure level of 104 dBA at 1 m) have been modelled using CadnaA. The predicted sound pressure levels at varying distances (as found in Chapter 11) range from 42 dBA at 1,000 m to 70 dBA at 50 m (Table 14.4.5-1). Mitigation includes ensuring that Project construction equipment is maintained so that noise control devices such as engine mufflers are working to specification.

Table 14.4.5-1 Predicted Sound Pressure Levels with Distance from the Horizontal Directional Drill Rig

Distance (m)	Sound Pressure Level (dBA)
50	70
100	64
200	57
300	54
400	51
500	49
1000	42

Note: From Chapter 11 (Table 11.2.5-11).

During late summer and autumn this noise and disturbance will likely cause a change in Shorebird behaviour from feeding or roosting to avoidance behaviour. This will cause a change in habitat use by Shorebirds, and they would relocate from the intertidal zone or coastal heathlands at the electrode sites to other nearby areas with similar habitat.

Shoal Cove is known to host moderate numbers of White-rumped Sandpipers and small numbers of other species. The amount of suitable habitat for Migrating Shorebirds at Forteau Point is unknown. However, habitat in nearby coves can support displaced shorebirds, so the effect is expected to be minimal. In addition, the landing sites (i.e., where HDD and human activity will occur) will be located approximately 100 m from the shoreline, where noise pressure levels will be attenuated to 64 dBA (Table 14.4.5-1), which will likely reduce disturbance to intertidal areas. As a result, these species abundance is unlikely to be affected by submarine cable landing site construction activities.

The shoreline electrode site preparation and installation at L'Anse au Diable and Dowden's Point may interact with Migrating Shorebirds if conducted during late summer and autumn and if the shorebirds are present. The construction-related noise and disturbance will likely cause a change in shorebird behaviour from feeding and roosting to avoidance behaviour. This will cause a change in habitat use by shorebirds, and they would relocate from the intertidal zone or coastal heathlands at the electrode sites to other nearby areas with similar habitat.

Berm construction and installation of the electrodes may convert a small area of intertidal zone shorebird habitat, if present, to rock rubble. However, the substrate in the intertidal and subtidal areas at the L'Anse au Diable site is 51% bedrock and the remainder is dominated by sand with low organic content with low biomass of organisms (Sikumiut 2011a). This suggests that the site is of low quality for the Shorebird species that stage in the area. The shoreline electrode site at Dowden's Point has a substrate in the intertidal area composed exclusively of boulder / cobble and the subtidal area substrate is dominated by boulder / cobble (Sikumiut

2011a). Consequently, the area provides poor habitat for the migrating Shorebird species that stage in the area. The number of Shorebirds using either site is likely a small proportion of those species' total abundance. In addition, any displaced Shorebirds can be supported by habitat in nearby coves, so the effect on Shorebird species' total abundance is expected to be minimal. Occurrences of Red Knot *rufa* subspecies, a species at risk, are rare along the Strait of Belle Isle, and no habitat for this species has been identified. As a result, this subspecies' abundance is unlikely to be affected by Construction activities.

Considering the small areal extent of Construction activities, the relatively low sound pressure levels beyond 500 m (<49 dBA), the temporary nature of the activities, the amount of habitat affected, qualitative assessments of the habitat quality based on the nature of the substrates in the LSA and the numbers of Migrating Shorebirds known to use the affected areas, and using best professional judgement, Project Construction activities will likely have minimal interaction with habitat used by Migrating Shorebirds, and permanent effects to abundance and behaviour are not expected.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on the Migrating Shorebird KI are as follows:

- Adverse, because of the change in behaviour and habitat use (habitat alteration / loss and displacement of Shorebirds);
- Low in magnitude, because of the small change to Shorebird abundance (proportion of the Shorebird populations affected and the availability of nearby habitat to support Shorebirds);
- Limited to the LSA, because of the small affected area of the submarine cable landing sites and shoreline electrode sites;
- Far future in duration, because construction of the HDD and electrode sites will likely be completed over two summers; however, the effect will be evident throughout operations; and
- Low in frequency because Construction will only occur once at these locations.

There is a moderate degree of confidence that the level of effect will not be greater than predicted. Although SPLs from drilling will attenuate substantially with distance, the qualitative nature of the knowledge of the effects of most Project activities on the Migrating Shorebird KI and of the limited knowledge of the KI's populations using the affected areas results in uncertainty in the effects. Uncertainty is addressed in the EIS through conservative estimates and assumptions, and through adaptive management.

14.4.5.4 Construction Effects: Nesting Seabirds

As discussed under Construction Effects on Migrating Shorebirds, the effects of anthropogenic noise and disturbance can cause Seabirds to avoid feeding areas or roosting areas, increase energy demands or decrease feeding efficiency. Such changes could negatively affect nesting success. However, there are no data available to quantitatively predict the effects of Project noise and disturbance on Nesting Seabirds.

As discussed above, submarine cable landing site preparation and construction (on-land works) will involve the movement of heavy machinery and humans with associated noise. Drilling at Shoal Cove is scheduled to take 2.5 years and at Forteau Point it will take two years. During this time drilling will take place 24 hours per day, seven days per week. The sound pressure levels of a typical drill rig with a sound power level of 115 dBA (as calculated from the sound pressure level of 104 dBA at 1 m) have been modelled using CadnaA. The predicted SPLs at varying distances range from 42 dBA at 1,000 m to 70 dBA at 50 m. Mitigation includes ensuring that Project construction equipment is maintained so that noise control devices such as engine mufflers are working to specification.

Submarine cable landing site preparation and construction may affect Nesting Seabirds if the latter are feeding on pelagic species of fish spawning in inshore waters adjacent to the drill sites, typically in June and July

(Sikumiut 2010a). This noise and disturbance will likely cause a change in Nesting Seabird behaviour from feeding to avoidance behaviour. This will likely cause a change in local distribution by such seabirds, and they would relocate from the inshore areas off the drill sites to other nearby areas with similar habitat. As a result, these species' nesting success and abundance are unlikely to be affected by submarine cable landing site construction activities.

Electrode site preparation and installation at L'Anse au Diable and Dowden's Point may interact with Nesting Seabirds if the latter are feeding on pelagic species of fish spawning in those areas. Anecdotal reports suggest that capelin has spawned in L'Anse au Diable (Sikumiut 2010a). Movement of heavy machinery and humans, and associated noise may deter seabirds from the vicinity of the activity, thus restricting access to shallows where pelagic fish are spawning. Mitigation includes ensuring that Project construction equipment is maintained so that noise control devices such as engine mufflers are working to specification.

These Construction activities may affect Nesting Seabirds if the latter are feeding on pelagic species of fish spawning in inshore waters adjacent to the electrode sites. Noise and disturbance from these activities will likely cause a change in nesting seabird behaviour from feeding to avoidance behaviour. This will cause a change in local distribution by such seabirds, in which they would relocate from the inshore areas off the drill sites. It is likely that spawning events along the coast in nearby coves will provide alternate foraging areas for seabirds. Consequently, Nesting Seabirds' nesting success and abundance will not likely be affected by electrode site preparation and abundance.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on the Nesting Seabird KI are as follows:

- Adverse, because of the change in behaviour and distribution (habitat alteration / loss at the shoreline electrode sites and displacement of foraging seabirds).
- Low magnitude because of the low numbers of Nesting Seabirds likely to be attracted to the waters adjacent to submarine cable landing sites and shoreline electrode sites and because of the availability of alternate habitat to support these seabirds.
- Limited to the LSA, because of the small affected area adjacent to submarine cable landing sites and the shoreline electrode sites.
- Far future in duration. Construction of the electrode sites is expected to be completed over two summers; however, the effect will be evident throughout operations.
- Low in frequency because Construction will only occur once at these locations.

There is a moderate degree of confidence that the level of effect will not be greater than predicted. Although SPLs from drilling will attenuate substantially with distance, the qualitative nature of the knowledge of the effects of most Project activities on the Nesting Seabird KI and of the limited knowledge of the KI's populations using the affected areas results in uncertainty in the effects. Uncertainty is addressed in the EIS through conservative estimates and assumptions, and through adaptive management.

14.4.5.5 Construction Effects: At-sea Seabirds

Artificial Lighting Effects on Seabirds

Artificial lighting on ships at sea, offshore oil / gas drilling or production structures, coastal communities, and oceanic island communities regularly attracts nocturnally-active seabirds and nocturnally-migrating land- and water-birds, sometimes in large numbers (Montevecchi 2006). However, there have been no studies of strandings onboard cable-laying ships or rock-placement ships. Light attraction often results in bird mortality, occasionally due to collisions with nearby non-illuminated structures, or more rarely, with the lights themselves (Poot et al. 2008). However, most mortality occurs because these birds mill about near the lights and eventually land on the deck or ground, after which seabirds in this situation typically are unable to take off and eventually succumb to dehydration, starvation, exhaustion, or hypothermia or drowning in water-filled cavities on deck.

Birds may be attracted to artificial lighting from a distance of up to 5 km in the case of offshore oil and gas installations with 30 kW of lighting (Poot et al. 2008). The attraction of seabirds to artificial lighting occurs at all times of the year, but tends to be more common at the end of the nesting season (Miles et al. 2010). The majority of stranded seabirds near seabird nesting colonies are newly fledged young (Miles et al. 2010). Light attraction is also more common when moonlight levels are low due to low cloud ceiling, fog, rain or moon phase (Miles et al. 2010; Rodríguez and Rodríguez 2009; Telfer et al. 1987).

Attraction to artificial lighting and attendant grounding appears to be widespread among procellariiform seabird species, i.e., petrels, shearwaters and prions (Procellariidae), storm-petrels (Hydrobatidae), and diving-petrels (Pelecanoididae) (but not albatrosses Diomedeidae), having been observed in more than 20 species (Miles et al. 2010; Rodríguez and Rodríguez 2009; Montevecchi 2006). Species that occur in Newfoundland and Labrador waters and are attracted to artificial lighting include Common Eider, King Eider, Long-tailed Duck, Leach's Storm-Petrel, Manx Shearwater, Atlantic Puffin, Thick-billed Murre and Black Guillemot (Merkel 2010; Abgrall et al. 2008a, b). At high latitudes these species strand most commonly when young fledge from nesting colonies (late summer and early autumn) and when moonlight levels are lowest (Miles et al. 2010). However, data from a wintering area for Leach's Storm-Petrel show that adults are also attracted to artificial lighting (Rodríguez and Rodríguez 2009). It has been reported that a small Pacific species of auk, Crested Auklet (*Aethia cristatella*), stranded by the hundreds aboard a fishing vessel off Alaska (Dick and Donaldson 1978).

There are no data available to quantitatively predict the effects of artificial lighting from Project vessels or on-land Project equipment such as drill rigs in the Strait of Belle Isle RSA or the Conception Bay RSA, on at-sea seabirds.

Effects of Project Activities

Construction and installation of submarine cables (marine works) may interact with at-sea seabirds through artificial lighting at night on Project vessels, although only qualitative predictions of the number and species of seabirds are possible. This artificial lighting will likely lead to a change in behaviour of procellariiform seabirds (i.e., attraction to the lighting), in turn, leading to a change in seabird distribution. Attraction will likely cause seabird strandings on Project vessels which, unless mitigated, will cause a change in seabird abundance through mortality. Seabird collisions with Project vessels in poor visibility are a possibility and can also cause mortality leading to a change in seabird abundance.

Lighting will be reduced, and shielded from pointing skyward to reduce light attraction to the extent practical and feasible without affecting vessel and work safety. In addition, daily monitoring will be conducted of seabird stranding through searches of decks, and recovering and releasing stranded birds to the sea.

On-land works in the construction and installation of submarine cables may also cause attraction to artificial lighting on the HDD rig. However, quantitative data on the density and number pairs of nesting Leach's Storm-Petrels, the species most commonly stranded due to light-attraction suggest that density of this species at-sea is low during the fledging period. In addition, strandings are readily mitigated through reducing the use of non-essential lighting. Lighting will be reduced, and shielded from pointing skyward to reduce light attraction to the extent practical and feasible. These mitigations will minimize the effect on storm-petrel abundance.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Construction on the At-sea Seabird KI are as follows:

- Adverse in direction, because of negative changes in behaviour, distribution and abundance (mortality resulting from Seabird strandings and collisions);

- Low in magnitude because of the small proportions of the populations of susceptible species that occur in the RSA, and the effectiveness of available mitigation measures to reduce changes in abundance;
- Limited to the RSA because Seabirds may be attracted to artificial lighting at distances up to 5 km;
- Medium-term in duration, as effects are likely to be limited to the Construction period for the submarine cable and the electrode sites; and
- High in frequency because atmospheric conditions conducive to strandings and / or collisions of Seabirds are expected to occur ten times or more during the year of construction.

There is a high degree of confidence that the level of effect will not be greater than predicted. Although qualitative data were relied on, measures to mitigate seabird strandings due to attraction to artificial lighting have been demonstrated to be highly effective, resulting in a high degree of confidence that the effect of artificial lighting on At-sea Seabird abundance will be small.

14.4.6 Operations and Maintenance

14.4.6.1 Overview of Project Operations and Maintenance and Associated Effects Management

Routine line inspections and repairs (marine) and potential major system repairs may interact with Seabirds through Project vessels. As discussed above in the section on Construction effects on At-sea Seabirds, Seabirds may be attracted to artificial lighting on these vessels potentially causing mortality, and alcids and sea ducks may collide with Project vessels in poor visibility. Operations of the electrodes may interact with Seabirds through the generation of electrical and electromagnetic fields in the electrode saltwater ponds and Seabirds landing on the saltwater ponds.

Mitigation measures to avoid or limit Project effects of Operations and Maintenance on Seabirds include:

- Electrodes will be designed by Nalcor to minimize the electric and electromagnetic fields (e.g., through selection of electrode materials and maximization of electrode surface area). Under normal operating conditions electrodes will be operated as a bipole system that will involve only very low levels of electric current flowing through the electrodes (<1%).
- Attraction to artificial lighting is effectively mitigated through search of vessel decks for stranded Seabirds, recovery and release of these birds.
- Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

14.4.6.2 Existing Knowledge

Effects of Magnetic Field at Electrodes

A potential zone of influence (ZOI) of the Dowden's Point electrodes on marine fauna can be estimated using the modelling of the magnetic flux density (Hatch Ltd. 2011) and the sensitivities of animals as reported in the literature. To provide a conservative ZOI, a water depth of 0 m and an amperage of 2,109 (320 kV HVDC system) were chosen as the parameters. There would be two ZOI: (i) from a continuous and normal bipole system operation imbalance current at 14.06 A; and (ii) from the fault condition of monopole operation with a fault current of 2,109 A (predicted to occur less than 40 hours per year).

The 0 m water depth was chosen for this assessment because the induced magnetic field intensity at the surface is higher than at any other point in the water due to partial cancellation of flux at the top layer of water. The induced flux intensities will be zero at a point where currents in the water above and below the point are equal. The flux intensity at the bottom of the sea will be less than at the surface and in the opposite direction (about the z-axis). The change of sea surface elevation with the tide will result in lower magnetic field intensity since current magnitudes will remain the same but the observation will be farther from the water layers.

The 320 kV scenario was chosen because it would operate at a higher amperage than the 350 kV system (i.e., the proposed Project) and thus would create somewhat higher electric and electromagnetic fields.

A threshold of effects on marine fauna at a magnetic flux density of 200 nT (2 x 10^{-7} T) is a reasonable (and conservative) value to use to define the ZOI of the electrodes. Referring to Hatch Ltd. (2011), a surface ZOI for normal operations can be defined at some distance from the electrodes of equal to or less than 50 to 100 m (see Hatch Ltd. 2011, Tables 3-15 and 3-19, B_{res} values reported as natural Earth values plus those induced by the Project).

The upset condition where the system is operating in monopolar operation (i.e., maximum continuous current) results in a ZOI radius for the electrodes on the order of 500 m for L'Anse au Diable and Dowden's Point (see Hatch Ltd. 2011, Table 3-13 and 3-17, B_{res} values).

It should be noted that the 200 nT threshold was chosen at a conservative level where a diversity of marine animals (both invertebrates and vertebrates) may be able to detect and react (e.g., Kirschvink 1990; Semm and Beason 1990; Kirschvink et al. 1986; Walker and Bitterman 1989). Several species have been exposed to levels many times above this level with no reactions and no ill effects. Not all individuals or species will always react; and not all reactions will necessarily be negative. Delay or alterations in migratory patterns would be a potential negative effect but animals in the natural environment regularly encounter anomalies. For example, there are at least 27 geomagnetic events per year of 200 nT or more (NOAA 2011, internet site).

14.4.6.3 Operations and Maintenance Effects: Migrating Shorebirds

Electromagnetic Fields

Many species of birds, including Seabirds such as terns and shearwaters, undergo long migrations and much of the research on animal migration concerns bird navigation (Wiltschko and Wiltschko 2009). Although geomagnetic navigation has been demonstrated in several species of terrestrial birds, few seabirds have been studied. In experiments with juvenile Herring Gull and Ring-billed Gull, orientation to a migratory heading toward the species' usual wintering grounds is disrupted in experiments in which the earth's magnetic field is disturbed by magnetic storms or by the placement of magnets on the birds or in their cages (Moore 1975). In contrast, placing magnets on the heads of procellariiform seabirds (Black-browed Albatross *Thalassarche melanophris*, Wandering Albatross *Diomedea exulans*, and White-chinned Petrel *Procellaria aequinoctialis*) did not prevent them from homing to nesting colonies when returning from their typically long foraging trips (Bonadonna et al. 2005).

Electromagnetic fields are produced by the flow of current through cables and conductors, and also as electric current passes through other media such as the sea and soil. The magnitude of the EMF at a given point is dependent on the distance from the conductor, and the permeability of the medium. The electrode during operations will produce an EMF as current will flow into the sea and surrounding soil. As discussed in Section 14.4.4, the strength of the magnetic field at various distances from the electrode has been modelled to determine the ZOI during both normal bipolar operations and upset conditions when the electrode is operating under monopolar operations (i.e., at 100%).

There is little or no potential for Seabirds to be exposed to EMFs emitted by the Project at a level in the marine environment that would disrupt their navigational abilities, especially as they are known to use a variety of other navigational cues. There may be some potential for seabirds to be attracted to the electrodes if coincidentally there is concentrated prey in the LSA or if they are attracted to the electrode saltwater ponds for bathing or resting. However, the authors are not aware of this phenomenon being reported for the existing HVdc projects worldwide.

Electric Fields

When current is injected into or collected by an electrode, a ground potential rise (GPR) occurs in the area surrounding the electrode. The magnitude of the GPR is dependent on the current and the resistivity of the surrounding medium. The GPR gradient is measured in volts, and it is the difference in voltage over a given distance that results in an electric field. It is important to note that voltage itself does not cause the effect, but rather the difference in voltage which allows the flow of electricity between two points. Therefore, if a bird lands on the electrode saltwater pond, it can sit there safely. There does not appear to be any available literature on effects thresholds for electric fields and marine birds. Telstad (1994) suggests a level of 2.5 V/m as "unpleasant for animals and man".

Operation of the electrodes may interact with Migrating Shorebirds if the birds land on the electrode saltwater ponds to forage or rest. However, the electric field strength is not likely to cause more than an unpleasant sensation rather than injury or mortality, the response to which would likely be a minor change in behaviour, i.e., the birds would leave.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on the Migrating Shorebird KI are as follows:

- Adverse in direction, because of the change in behaviour in response to electric and electromagnetic fields;
- Low in magnitude because of the small proportions of the populations of susceptible species in the RSA that may be attracted by the electrode saltwater ponds and because of the small change in behaviour;
- Limited to the L'Anse au Diable LSA Component and Dowden's Point LSA Component, because of the small ZOI of the electrodes;
- Far future duration, because the effect would extend through Project Operations and Maintenance; and
- Continuous in frequency because the electrodes would be operating continuously.

There is a high degree of confidence that the level of effect on Migrating Shorebirds will not be greater than predicted because quantitative modelling conducted by Nalcor predict the electric and electromagnetic field strengths and the radius of the ZOI of those fields will be weaker than the electric and magnetic field strengths necessary to elicit responses in birds.

14.4.6.4 Operations and Maintenance Effects: Nesting Seabirds

Operation of the electrodes may interact with Nesting Seabirds, likely various diving duck species or cormorant species, if they land on the electrode saltwater ponds to shelter from heavy seas or to forage. As discussed above for Migrating Shorebirds, based on the quantitative modelling of electric and magnetic field strengths for the electrode saltwater ponds, and qualitative estimates of electric and magnetic field strengths necessary to be detectable by birds, Operations and Maintenance of the electrodes are unlikely to result in more than a minor change in nesting seabird behaviour. However, because this effect is likely to be negligible, it is not likely to affect distribution, abundance or nesting success of Nesting Seabirds.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on the Nesting Seabird KI are as follows:

- Adverse in direction, because of changes in behaviour in response to electric and magnetic fields at the electrode saltwater ponds;
- Low in magnitude because of the small change in behaviour in response to electric and magnetic fields;
- Limited to the L'Anse au Diable LSA Component and Dowden's Point LSA Component because of the small ZOI of the electrodes;

- Far future in duration as the effect would extend through Project Operations and Maintenance; and
- Continuous in frequency because the electrodes would be operating continuously.

There is a high degree of confidence that the level of effect on Nesting Seabirds will not be greater than predicted because quantitative modelling conducted by Nalcor predict the electric and magnetic field strengths and the radius of the ZOI of those fields will be weaker than the electric and magnetic field strengths necessary to elicit responses in birds, as derived from qualitative estimates.

14.4.6.5 Operations and Maintenance Effects: At-sea Seabirds

Artificial Lighting Effects on Seabirds

As discussed under Construction effects, qualitative data suggest that At-sea Seabirds (especially procellariiform species such as Leach's Storm-Petrel) will likely be attracted to artificial lighting on board Project vessels. Routine line inspections and repairs, and potential major system repairs (marine) may interact with At-sea Seabirds through changes in behaviour and distribution (attraction to artificial lighting) leading to stranding or through collisions in poor visibility. Both could lead to changes in abundance of At-sea Seabirds. However, with mitigation measures in place such as search, recovery and release of Seabirds from vessel decks, such changes in behaviour, distribution and abundance are likely to be minimal.

Operation of the electrodes may interact with At-sea Seabirds, likely various diving duck species or cormorant species, if they land on the electrode saltwater ponds to shelter from heavy seas or to forage. As discussed above, based on the quantitative modelling of electric and magnetic field strengths for the electrode saltwater ponds, and qualitative estimates of electric and magnetic field strengths necessary to be detectable by birds, Operations and Maintenance of the electrodes are unlikely to result in more than a minor change in At-sea Seabird behaviour. Because this effect is minimal, it is not likely to affect At-sea Seabird distribution or abundance.

Summary of Likely Residual Environmental Effects

The likely residual effects of Project Operations and Maintenance on the At-sea Seabird KI are as follows:

- Adverse in direction, because of changes in behaviour, distribution and abundance resulting from seabird strandings and collisions and response to electric and magnetic fields at electrode saltwater ponds;
- Low in magnitude because of the small proportions of the populations of susceptible species that occur in the RSA, and the effectiveness of proposed mitigation measures;
- Limited in geographic extent to the LSA, because of the small affected area of the shoreline electrode sites and because of the limited distance to which artificial lighting attracts seabirds;
- Far future in duration as the effect would extend through Project Operations and Maintenance; and
- Continuous in frequency because the electrodes would be operating continuously.

There is a high degree of confidence that the level of effect on At-sea Seabirds will not be greater than predicted because quantitative modelling conducted by Nalcor predict the electric and magnetic field strengths and the radius of the ZOI of those fields will be weaker than the electric and magnetic field strengths necessary to elicit responses in birds, as derived from qualitative estimates. This also considers the qualitative estimates of the low numbers of Seabirds attracted to artificial lighting and the effectiveness of the corresponding mitigation.

14.4.7 Environmental Effects Summary and Evaluation of Significance

14.4.7.1 Summary of Environmental Effects

The Project effects on all of the Seabird KIs (Migrating Shorebird, Nesting Seabird and At-sea Seabird) are summarized in Table 14.4.7-1 to determine the effects of the Project on the Seabirds VEC.

Table 14.4.7-1 Environmental Effects Analysis Summary: Seabird VEC

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Construction					
Migrating Shorebirds	**Adverse** – Change in behaviour and habitat use (habitat alteration / loss and displacement of Migrating Shorebirds)	**Low** – Small change to shorebird abundance (proportion of the shorebird populations affected and the availability of nearby habitat to support Migrating Shorebirds)	**Local** – Limited to LSA because of small affected area of the landing and shoreline electrode sites	**Far Future** – Construction of the HDD and electrode sites is expected to be completed over two summers; however, the effect will be evident throughout Operations and Maintenance	**Low** – Construction will only occur once at these locations
Nesting Seabirds	**Adverse** – Change in behaviour and distribution (habitat alteration / loss at the shoreline electrode sites and displacement of foraging Seabirds)	**Low** – Low numbers of Nesting Seabirds expected to be attracted to the waters adjacent to submarine cable landing sites and shoreline electrode sites and because of the availability of alternate habitat to support these seabirds	**Local** – Limited to LSA because of small affected area adjacent to submarine cable landing sites and the shoreline electrode sites	**Far Future** – Construction of the electrode sites is expected to be completed over two summers; however, the effect will be evident throughout Operations and Maintenance	**Low** – Construction will only occur once at these locations
At-sea Seabirds	**Adverse** – Change in behaviour, distribution and abundance (mortality resulting from At-sea Seabird strandings and collisions)	**Low** – Small proportions of the populations of susceptible species, effectiveness of mitigation measures to limit changes in abundance	**Regional** – May extend into the Strait of Belle Isle RSA and Conception Bay RSA because of the distance (up to 5 km) that artificial lighting attracts At-sea Seabirds	**Medium-term** – Limited to the Construction period for the submarine cable and the electrode sites	**High** – Atmospheric conducive to strandings and / or collisions of At-sea Seabirds are expected to occur ten times or more in each year of Construction

Table 14.4.7-1 Environmental Effects Analysis Summary: Seabird VEC (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
Summary of Likely Residual Construction Effects on Seabirds: The effects of the Project Construction on the Seabirds VEC will likely be limited in extent and magnitude, with proven mitigation applied. The Project is not likely to affect the behaviour, distribution or populations of Seabirds at the regional level.					
Operations and Maintenance					
Migrating Shorebirds	**Adverse** – Change in behaviour in response to electric and magnetic fields	**Low** – Small proportions of populations of susceptible species may be attracted by the electrode saltwater ponds, small change in behaviour	**Local** – Limited to L'Anse au Diable LSA Component and Dowden's Point LSA Component, small zone of influence of the shoreline electrode sites	**Far Future** – Effect would extend through Project Operations and Maintenance	**Continuous** – Electrodes would be operating continuously
Nesting Seabirds	**Adverse** – Changes in behaviour in response to electric and magnetic fields at electrode saltwater ponds	**Low** – Small change in behaviour in response to electric and magnetic fields	**Local** – Limited to L'Anse au Diable LSA and Dowden's Point LSA Components because of the small zone of influence of the electrodes	**Far Future** – Effect would extend throughout Project Operations and Maintenance	**Continuous** – Electrodes would be operating continuously

Table 14.4.7-1 Environmental Effects Analysis Summary: Seabird VEC (continued)

Project Phase / Key Indicator	Likely Residual Environmental Effects Summary Descriptors				
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**
At-sea Seabirds	**Adverse** – Changes in behaviour, distribution and abundance resulting from At-sea Seabird strandings and collisions; response to electric and magnetic fields at electrode saltwater ponds	**Low** – Small proportions of the populations of susceptible species occurring in RSA; effective mitigation measures	**Local** – Limited to Corridor LSA, L'Anse au Diable LSA and Dowden's Point LSA Components; small zone of influence of electrodes; limited distance to which artificial lighting attracts At-sea Seabirds	**Far Future** – Effect would extend throughout Project Operations Maintenance	**Continuous** – Electrodes would be operating continuously
Summary of Likely Residual Operations and Maintenance Effects on Seabirds: The effects of the Project Operations and Maintenance on the Seabirds VEC are predicted to limited in extent and magnitude, with proven mitigation applied. The Project is not expected to affect the behaviour, distribution or populations of Seabirds at the regional level.					

14.4.7.2 Definition and Determination of Significance

Significant environmental effects are those that are considered to be of sufficient magnitude, duration and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. For the purposes of this EIS, significant environmental effects are those that are likely to pose serious risk to the Seabird VEC and represent a management challenge, have a duration into the long-term and extend beyond the RSA.

Assessment of the potential direction, magnitude, geographic extent, duration and frequency of the effects of Project Construction, and Operations and Maintenance activities on each of the KIs informed determination of significance of these effects on the Seabird VEC. This was based on the descriptions of the activities associated with Project Construction, and Operations and Maintenance, with integral consideration of the mitigation, an understanding of the RSA baseline conditions and associated resilience of the Seabird VEC. Based on this information the likely residual effects on the Seabird VEC were predicted.

A qualitative assessment of the effects of noise, disturbance and habitat alteration / loss potentially resulting from the preparation and construction of the submarine cable landing sites, and electrode site preparation and installation on the Migrating Shorebirds KI resulted in the conclusion that these Project activities will likely have a small, adverse change in behaviour and habitat use (i.e., will cause shorebirds to move to other similar habitat in the area). Based on existing knowledge of bird use of the Corridor LSA Component (especially in the vicinity of the cable landing site at Shoal Cove), and quantitative data on the organic and faunal characteristics of the sediment and substrate at both electrode site LSAs, the magnitude will likely be low because of the small change in abundance (the number of affected birds displaced from the affected areas will likely be small and can be supported by nearby habitat). Considering these factors, the effect will likely be limited to the LSA.

The effects of noise, disturbance and habitat alteration / loss arising from Construction activities on the Nesting Seabirds KI were assessed using qualitative data. These Project activities will likely have a low, adverse change in behaviour and distribution (i.e., will cause Nesting Seabirds to move to other similar habitat in the area to forage). The effects will likely be be limited to the LSA because the ZOI of sound and the amount of habitat lost will be limited to within a few hundred metres of the construction areas. Because of these factors the Project activities will likely have no measurable effect on Nesting Seabird abundance or nesting success.

Preparation and construction of the submarine cable landing sites and construction and installation of submarine cables on At-sea Seabirds was assessed qualitatively and determined to have an adverse effect because of changes in behaviour, distribution and abundance on this KI due to attraction to artificial lighting on and potential collisions with Project vessels. However, the magnitude of the effect will likely be low because only a small proportion of the populations will likely be affected, the effect will be limited to the LSA, will occur over the short-term and adverse atmospheric conditions will likely occur more than 10 times a year. With the proposed mitigation in place the effects on At-sea Seabird behaviour, distribution and abundance was judged will likely be negligible.

The effect of Operations and Maintenance (routine line inspection and repairs, potential major system repairs and operation of electrodes) on the At-sea Seabird KI was determined to have adverse changes on behaviour, distribution and abundance because of seabird strandings due to light attraction, potential collisions with vessels and responses to electric and magnetic fields at the electrode saltwater ponds. The magnitude was assessed to be low because of the small proportions of the seabird populations affected. The effect will likely be limited to the LSA. Mitigation of bird strandings will result in a negligible effect of light attraction. Although the effect of electrode operations will be continuous, only small numbers of birds will likely be affected.

The effects of electrode operations on the Migrating Shorebird KI and Nesting Seabirds KI were determined to cause adverse changes in behaviour in response to electric and magnetic fields at the electrode saltwater ponds. However, because the magnitude will likely be low as a result of the small response to the electric and magnetic fields, and because the effect will be limited to the LSA due to the small ZOI of the electrodes, the effects on these KIs' behaviour, habitat use, distribution, nesting success and abundance will likely be negligible.

The residual effects of Project Construction, and Operations and Maintenance activities on each of the KIs will be adverse in direction. However the Project will not likely pose a serious risk to the Seabirds VEC nor represent a serious management challenge, with only limited effects extending into the far future duration and will not extend beyond the LSA.

No detectable change to the abundance, distribution, behaviour, habitat use or nesting success of Seabirds in the RSA will likely occur as a result of the Project. Therefore, the Project is not likely to result in significant adverse environmental effects on the Seabirds VEC.

14.4.8 Evaluation of Project Alternatives

Alternatives were considered as part of the Project design as discussed in Chapter 2, Section 2.12. No technically and economically feasible alternatives for the submarine cable crossing or the shoreline electrode sites were identified, and therefore Project alternatives are not evaluated for the Marine Environment.

14.4.9 Cumulative Environmental Effects

This section of the EIS assesses the overall effect on the Seabird VEC as a result of the Project's likely residual environmental effects that overlap both spatially and temporally with other likely effects within the RSA from past, present and reasonably foreseeable projects and activities. The future projects and activities considered for the cumulative effects assessment included the potential future changes to the intensity / nature / distribution of fishing activity in the Strait of Belle Isle. Note, the Maritime Link listed in Table 9.3.9-2 for the Marine Environment is not considered in the cumulative effects assessment on Seabirds as this development does not overlap spatially with the Project and is not in proximity to the RSA, and therefore no cumulative effects are anticipated. Table 14.4.9-1 presents the cumulative environmental effects summary for the Seabird VEC.

The effects of the Project in combination with other projects and activities that have been or will be carried out are not expected to pose serious risk to the Seabird VEC and represent a management challenge, have a duration into the long-term and extend beyond the RSA. Therefore, significant cumulative effects on the Seabirds VEC are not likely to occur. The planning, consultative and other effects management measures identified for this VEC will serve to avoid or reduce potential interactions and effects as a result of the Project. Avoiding or managing potential effects on the Seabirds VEC resulting from other ongoing and future projects and activities will require that appropriate resource management, planning, regulatory and enforcement measure are in place and implemented by the relevant agencies.

Additional mitigation measures are not considered to be necessary to eliminate or reduce cumulative effects on Seabirds.

Table 14.4.9-1 Cumulative Environmental Effects Summary: Seabirds VEC

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle [a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula [b]
Current (Baseline) VEC Condition (Reflecting the Effects of Past and Ongoing Projects and Activities)	n/a	– Most species of the Seabird VEC have stable population sizes or are slowly increasing or decreasing[d][e] – Ivory Gull population declining rapidly[f] – Razorbill numbers nesting on Gannet Islands may be declining in number due to hunting[g]	n/a	n/a	– Most species of the Seabird VEC have stable population sizes or are slowly increasing or decreasing[d][e] – Ivory Gull population declining rapidly[f]
Likely Residual Environmental Effects of Labrador-Island Transmission Link (Reflecting Current VEC Condition, As Above)	n/a	– The residual effects resulting from the Project include: habitat loss / alteration at the landing site at Forteau Point and the L'Anse au Diable electrode site; construction related disturbance (i.e., human activity and noise) from equipment and vessels; mortality resulting from strandings or collisions with vessels	n/a	n/a	– The residual effects resulting from the Project include: habitat loss / alteration at the Dowden's Point electrode site; construction related disturbance (i.e., human activity and noise) from equipment and vessels; and disturbance related to electric fields and EMF at the Dowden's Point electrode site during operations
Likely Cumulative Environmental Effects (within RSA) of Other Future Projects and Activities	n/a	– Overlapping effects would be limited to marine vessel traffic within the RSA, and the related disturbance and potential for strandings	n/a	n/a	– Overlapping effects would be limited to disturbance from marine vessel traffic within the RSA and the related disturbance and potential for strandings

Table 14.4.9-1 Cumulative Environmental Effects Summary: Seabirds VEC (continued)

Cumulative Effects Analysis	Central and Southeastern Labrador	Strait of Belle Isle [a]	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula [b]
Cumulative Environmental Effects Summary[c]	n/a	**Not Significant** – Due to the minimal effect and limited overlap, the cumulative effect of likely Project effects that overlap both temporally and geographically with other past, present and reasonably foreseeable projects and activities is not likely to be significant.	n/a	n/a	**Not Significant** – Due to the minimal effect and limited overlap, the cumulative effect of likely Project effects that overlap both temporally and geographically with other past, present and reasonably foreseeable projects and activities is not likely to be significant.

n/a Not applicable.
(a) Marine environment. Applicable to the Marine VECs only.
(b) For the Marine VECs, this area comprises the Island of Newfoundland electrode site only.
(c) Total (cumulative) change from the existing environment. Significance of cumulative effects evaluated using same definitions as for the Project Environmental Effects Analysis.
(d) Gaston et al. (2009).
(e) Goulet and Robertson (2007).
(f) Gilchrist and Mallory (2005).
(g) Lavers et al. (2009).

14.4.10 Monitoring and Follow-up

During Project Construction and routine inspections during Operations and Maintenance, Nalcor will note any incidents related to effects on Seabirds (e.g., stranding) and address these issues appropriately through their adaptive management process. Any adverse residual effects from Project activities are likely to be within the normal range of variability for the species potentially affected.

14.5 Environmental Assessment Summary

Project effects on the marine habitat during Construction are predicted to range from short-term disturbance through increased seawater turbidity to medium-term disturbance through alteration of the Benthic Habitat until re-colonization occurs. Effects on marine species during Construction are predicted to be primarily behavioural responses (temporary and localized avoidance of areas of Construction activity) as a result of noise and physical activity. The environmental effects on the Marine Environment during Construction are predicted to be not significant.

Similarly, during Operations and Maintenance, Project effects on marine species are predicted to be primarily temporary and localized avoidance as a result of noise and physical disturbance; changes in behaviour of marine species may also result from emission of EMFs over the period of Project Operation and Maintenance. Marine habitat, including benthic organisms, and fish and wildlife species using the marine environment may also be adversely affected by the accidental release of hydrocarbons from construction equipment. However, habitat effects are likely to be localized and readily mitigated in the case of small spills or leaks, and marine species are likely to avoid ships or vessels and equipment used during construction or maintenance activities. The environmental effects on the marine VECs and hence the Marine Environment during Operation and Maintenance are predicted to be not significant.

Cumulative effects on the Benthic Habitat and marine species associated with the Project and other past and ongoing anthropogenic projects and activities are likely to occur as a result of vessel traffic, dredging and other activities in the Strait of Belle Isle and Conception Bay. Given the primarily localized and short to medium-term nature of predicted Project effects, the standard practices and proven mitigation measures used during Construction and Operations and Maintenance, the Project’s contribution to cumulative effects on the Marine Environment in the RSA will likely be minimal.

The Project effects, including cumulative effects, are not predicted to affect populations, distributions or activities (e.g., feeding, spawning, and migration) of marine VECs at a regional scale, and therefore are not likely to be significant.

14.5.1 Effects Management Measures

Table 14.5.1-1 and Table 14.5.1-2 provide a summary of the effects management measures that Nalcor has incorporated into the Project for Construction, and Operations and Maintenance, respectively. Nalcor has designed the marine Project components specifically to address identified issues, and is proposing to use best management practices and mitigation options designed to avoid or limit the effects of the Project. Further, through their adaptive management process, Nalcor will assess issues that arise during Construction and Operations and Maintenance phases to allow appropriate changes to be made to mitigation strategies or methods, and adopted in a timely manner.

Table 14.5.1-1 Construction Mitigation Strategies and Methods – Marine Environment

VEC	Proposed Mitigation
Marine Fish and Fish Habitat	– Compensation works approved by DFO will mitigate the direct loss of marine fish habitat caused by rock placement and dredging. – Controlled rock placement with a fall pipe will be employed to minimize the amount of natural habitat coverage (i.e., direct loss of habitat). – Cable corridor will not be swept prior to cable installation. – Chemically-benign rock will be used for berm construction to minimize the effect on seawater and surficial sediment chemistry. – Construction time will be minimized to decrease the amount of exposure to vessel noise by invertebrates and fishes. – Drill mud will be recovered from the bore holes and conduit to the extent possible. – Drill mud will be recycled and the cuttings will be disposed of on land. – Silt curtains will be deployed during electrode site dredging to minimize the extent of increased turbidity. – Proper protocols will be implemented to avoid accidental introduction of potentially deleterious substances to the marine environment including all applicable regulations to minimize effect on seawater and surficial sediment chemistry. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Spill kits and trained personnel will be present on-site at all times, allowing for prompt containment. – A spill response team will be formed and trained. – Spills will be reported to the appropriate authority. – Fuelling or serving or mobile equipment on-land will not be permitted within 50 m of a waterbody. – The SHERP (Safety, Health and Environment Emergency Response Plan) will contain spill prevention and response plan. – The EPP (Environmental Protection Plan) will contain conditions for fuel handling and storage, including procedures for spill response.
Marine Mammals and Sea Turtles	– Project vessels will maintain constant course and speed whenever possible. – Project vessels will detour around Marine Mammals and Sea Turtles if feasible. – Construction will be completed as quickly as safety allows, thus decreasing the amount of vessel noise. – Vessels will be outfitted, operated and maintained to limit the potential for inadvertent releases of contaminants (e.g., oil) including proper protocols will be implemented to avoid accidental introduction of potentially deleterious substances to the marine environment including all applicable regulations to minimize effect on seawater. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Spill kits and trained personnel will be present on-site at all times, allowing for prompt containment. – A spill response team will be formed and trained. – Spills will be reported to the appropriate authority. – Fuelling or serving or mobile equipment on-land will not be permitted within 50 m of a waterbody. – The SHERP (Safety, Health and Environment Emergency Response Plan) will contain spill prevention and response plan. – The EPP (Environmental Protection Plan) will contain conditions for fuel handling and storage, including procedures for spill response.

Table 14.5.1-1 Construction Mitigation Strategies and Methods – Marine Environment (continued)

VEC	Proposed Mitigation
Seabirds	– Construction time will be minimized to decrease the amount of interaction with seabirds. – Project construction equipment will be maintained to ensure that noise control devices such as engine mufflers are working to specification. – Vessels will be outfitted, operated and maintained to limit the potential for inadvertent releases of contaminants (e.g., oil) including proper protocols will be implemented to avoid accidental introduction of potentially deleterious substances to the marine environment including all applicable regulations to minimize effect on seawater. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies. – Spill kits and trained personnel will be present on-site at all times, allowing for prompt containment. – A spill response team will be formed and trained. – Spills will be reported to the appropriate authority. – Fuelling or serving or mobile equipment on-land will not be permitted within 50 m of a waterbody. – The SHERP (Safety, Health and Environment Emergency Response Plan) will contain spill prevention and response plan. – The EPP (Environmental Protection Plan) will contain conditions for fuel handling and storage, including procedures for spill response – Daily monitoring will be conducted of seabird stranding through searches of decks, and recovering and releasing stranded birds to the sea. – Lighting will be reduced, and shielded from pointing skyward to reduce light attraction to the extent practical and feasible (i.e., without compromising worker and vessel safety). – The size of the electrode sites will be limited to that required to safely and efficiently construct the system.

Table 14.5.1-2 Operations and Maintenance Mitigation Strategies and Methods – Marine Environment

VEC	Proposed Mitigation
Marine Fish and Fish Habitat	– Cable armouring and insulation will maintain the same electric potential as outside ambient conditions and thus will confine the electric field to the inside of the cable. – The protective rock berm will further minimize any potential stray electric fields. – Underwater rock berm will serve as a partial barrier to the EMF generated by the cable. – The cable will be laid on the seabed rather than buried which reduces the potential for a temperature increase to occur to the seabed and the associated biota. – The rock breakwater berm at each electrode site will act as a barrier for invertebrates and fishes. – Routine visual inspections will be conducted with a ROV. – Electrodes will be designed to minimize electric and magnetic fields (e.g., through electrode design, electrode materials, electrode surface area, low resistivity surroundings). – Operation of electrodes under normal conditions as a bipole system will involve only low levels of electric current flowing through the electrodes (<1%). – Operation of electrodes under upset conditions as a monopole system will be limited to the time required to do repairs. – Contact area between the shoreline saltwater pond and the breakwater will be minimized to create a safe voltage gradient on the sea side of the breakwater. – The system is designed to require less than 40 hours per year of monopolar operations (100%). – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.
Marine Mammals and Sea Turtles	– Project vessels will maintain constant course and speed to the extent practical. – Project vessels will detour around Marine Mammals and Sea Turtles if feasible. – Screen / armouring of the cable is on the same electric potential as the outside ambient so that the electric field is confined to the inside of the cable. – Submarine cable armour and protective rock berm will minimize electric fields. – The rock berm will serve as a partial barrier to the EMF generated by the cable. – Electrodes will be designed to minimize electric and magnetic fields (e.g., through electrode design, electrode materials, electrode surface area, low resistivity surroundings). – Operation of electrodes under normal conditions as a bi-pole system will involve only very low levels of electric current flowing through the electrodes (<1%). – Minimization of contact area between the shoreline saltwater pond and the breakwater to ensure a safe voltage gradient on the sea side of the breakwater. – Routine visual inspections of the submarine cable will be completed with a ROV. – The system is designed to require less than 40 hours per year of monopolar operations (100%). – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.
Seabirds	– Electrodes will be designed by Nalcor to minimize the electric and electromagnetic fields (e.g., through selection of electrode materials and maximization of electrode surface area). Under normal operating conditions electrodes will be operated as a bipole system that will involve only very low levels of electric current flowing through the electrodes (<1%). – The system is designed to require less than 40 hours per year of monopolar operations (100%), – Attraction to artificial lighting is effectively mitigated through the search of vessel decks for stranded seabirds, and recovery and release of these birds. – Biodegradable lubricants and hydraulic fluids will be used where practical, when working near waterbodies.

14.5.2 Species of Special Conservation Concern

A list of marine species of conservation concern was presented in Table 10.5.11-3 (Chapter 10). This section summarizes how the protected species (i.e., those on *SARA* Schedule 1 or *NLESA*) and those species being assessed by COSEWIC and the NL SSAC that have the potential to interact with the Project are addressed in this assessment. Table 14.5.2-1 indicates how such species are addressed, provides a brief description of the predicted effects, and an indication of the likely significance of Project effects. The marine species of special conservation concern were not evaluated separately; consequently, no species-specific effects predictions and significance determinations have been made. Residual effects on these species have been captured under the Fish KI unter the Marine Fish and Fish Habitat VEC as not significant.

Table 14.5.2-1 Summary Effects: Species of Special Conservation Concern – Marine Environment

Species of Concern[(a)(b)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Fish			
White Shark	Effects and mitigation captured as part of the Fish KI under the Marine Fish and Fish Habitat VEC	– Temporary behavioural responses (e.g., avoidance of specific areas during Construction) by fish due to underwater construction activity and noise – Limited injury or mortality of fishes during Construction – Behavioural responses to underwater noise, electric fields and EMFs from the submarine cable and shoreline electrodes during Project Operations and Maintenance – Health effects to fishes in the event of accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons)	Not significant
Atlantic Wolffish	Effects and mitigation captured as part of the Fish KI under the Marine Fish and Fish Habitat VEC	– Temporary behavioural responses (e.g., avoidance of specific areas during Construction) by fish due to underwater construction activity and noise – Limited injury or mortality of fishes during Construction – Behavioural responses to underwater noise, electric fields and EMFs from the submarine cable and shoreline electrodes during Project Operations and Maintenance – Health effects to fishes in the event of accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons)	Not significant
Northern Wolffish	Effects and mitigation captured as part of the Fish KI under the Marine Fish and Fish Habitat VEC	– Temporary behavioural responses (e.g., avoidance of specific areas during construction) by fish due to underwater Construction activity and noise – Limited injury or mortality of fishes during Construction – Behavioural responses to underwater noise, electric fields and EMFs from the submarine cable and shoreline electrodes during Project Operations and Maintenance – Health effects to fishes in the event of accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons)	Not significant

Table 14.5.2-1 Summary Effects: Species of Special Conservation Concern – Marine Environment (continued)

Species of Concern[(a)(b)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Spotted Wolffish	Effects and mitigation captured as part of the Fish KI under the Marine Fish and Fish Habitat VEC	– Temporary behavioural responses (e.g., avoidance of specific areas during Construction) by fish due to underwater construction activity and noise – Limited injury or mortality of fishes during Construction – Behavioural responses to underwater noise, electric fields and EMFs from the submarine cable and shoreline electrodes during Project Operations and Maintenance – Health effects to fishes in the event of accidental releases of small amounts of potentially deleterious substances (e.g., hydrocarbons)	Not significant
Marine Mammals and Sea Turtles			
Blue Whale (Northwest Atlantic Ocean population)	Effects and mitigation captured as part of the Baleen Whales KI under the Marine Mammals and Sea Turtles VEC	– Temporary behavioural response, i.e., avoidance of underwater construction activities at a particular location, within the LSA and potentially extending beyond the LSA but confined within the RSA – Hearing impairment and mortality are unlikely as a result of underwater noise – Avoidance of maintenance activities – Potential for a behavioural response to EMFs – Mortality from vessel collisions is unlikely – Effects are unlikely to pose a serious risk to whales or represent a management challenge	Not significant
Fin Whale (Atlantic Ocean population)	Effects and mitigation captured as part of the Baleen Whales KI under the Marine Mammals and Sea Turtles VEC	– Temporary behavioural response, i.e., avoidance of underwater construction activities at a particular location, within the LSA and potentially extending beyond the LSA but confined within the RSA – Hearing impairment and mortality are unlikely as a result of underwater noise – Avoidance of maintenance activities – Potential for a behavioural response to EMFs – Mortality from vessel collisions is unlikely – Effects are unlikely to pose a serious risk to whales or represent a management challenge	Not significant
Leatherback Sea Turtle	Effects and mitigation captured as part of the Sea Turtles KI under the Marine Mammals and Sea Turtles VEC	– Temporary behavioural response, i.e., avoidance of construction activities at a particular location, within the LSA and potentially extending beyond the LSA but confined within the RSA – Hearing impairment and mortality are unlikely as a result of noise – Avoidance of maintenance activities – Potential for a behavioural response to EMFs – Mortality from vessel collisions is unlikely – Effects are unlikely to pose a serious risk to sea turtle or represent a management challenge	Not significant

Table 14.5.2-1 Summary Effects: Species of Special Conservation Concern – Marine Environment (continued)

Species of Concern[(a)(b)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Seabirds			
Harlequin Duck (eastern population)	Effects and mitigation captured as part of the At-sea Seabirds KI under the Seabirds VEC	– Change in behaviour, distribution and limited changes in abundance (mortality resulting from seabird strandings and collisions) during the Construction period for the submarine cable and the electrode sites – Changes in behaviour, distribution and limited changes in abundance resulting from strandings and collisions during Operations and Maintenance – Behavioural response to electric and magnetic fields at electrode saltwater ponds throughout Project Operations because electrodes would operate continuously – Effects limited to the marine LSAs during Construction and during Operations and Maintenance	Not significant
Barrow's Goldeneye (eastern population)	Effects and mitigation captured as part of the At-sea Seabirds KI under the Seabirds VEC	– Change in behaviour, distribution and limit changes in abundance (mortality resulting from seabird strandings and collisions) during the Construction period for the submarine cable and the electrode sites – Changes in behaviour, distribution and abundance resulting from strandings and collisions during Operations and Maintenance – Behavioural response to electric and magnetic fields at electrode saltwater ponds throughout Project Operations because electrodes would operate continuously – Effects limited to the marine LSAs during Construction and during Operations and Maintenance	Not significant
Ivory Gull	Effects and mitigation captured as part of the At-sea Seabirds KI under the Seabirds VEC	– Change in behaviour, distribution and limit changes in abundance (mortality resulting from seabird strandings and collisions) during the Construction period for the submarine cable and the electrode sites – Changes in behaviour, distribution and abundance resulting from seabird strandings and collisions during Operations and Maintenance – Behavioural response to electric and magnetic fields at electrode saltwater ponds throughout Project Operations because electrodes would operate continuously – Effects limited to the marine LSAs during Construction and during Operations and Maintenance	Not significant

Table 14.5.2-1 Summary Effects: Species of Special Conservation Concern – Marine Environment (continued)

Species of Concern[(a)(b)]	How Addressed in the EIS	Summary of Likely Residual Effects	Determination of Significance
Red Knot, *rufa* subspecies	Effects and mitigation captured as part of the Migrating Shorebirds under the Seabirds VEC	– Change in behaviour and habitat use (habitat alteration / loss and displacement of shorebirds) – Limited to the small affected area (i.e., landing and shoreline electrode sites) within the LSA, and occurrences are rare along the Strait of Belle Isle, and no habitat for this species has been identified – Behavioural response to electric and magnetic fields and attraction to electrode saltwater ponds – Effect would extend through Project operations because electrodes would operate continuously	Not significant

(a) Only Species of Special Conservation Concern that are present within the Study Area are included in this analysis. See Section 10.5.11 (Existing Environment) for information about species presence.

(b) American eel, a catadromous species, is addressed in Section 13.4.2 as part of the Fish Abundance and Species Assemblage KI of the Fish and Fish Habitat VEC in the assessment of the Freshwater Environment.

Based on the planned construction practices, Operations and Maintenance protocols, and mitigation measures to be implemented as part of the Project, environmental effects on marine species of special concern as a result of Project are likely to be of low to moderate magnitude, local to regional and far future geographic extent, and short-term to far future duration. The Project effects, including cumulative effects, are not predicted to affect populations, distributions or activities (e.g., feeding, spawning, and migration) of species at a regional scale, and are considered to be not significant.

14.5.3 Accidents and Malfunctions

Chapter 5 identifies and describes potential incidents (i.e., accidents and malfunctions) related to Project Construction, and Operations and Maintenance. It also describes the potential environmental consequence (i.e., magnitude, extent, and duration) of these incidents and their probability of occurrence. The risk of each incident, a function of both probability of occurrence and environmental consequence, was then assessed as low, moderate or high.

Incidents that are considered to have low risk (i.e., have a low to high probability of occurrence, and a low consequence, such as a small spill of diesel fuel) are assessed as part of the environmental effects assessment for potentially affected Marine VECs in this chapter. Incidents that are considered to have a moderate to high risk and have potential effects on the marine environment are addressed in this section. Table 14.5.3-1 lists the moderate to high risk incidents that may affect the marine environment. Table 14.5.3-1 also summarizes the likely effects of the incident and describes the prevention and response measures that will be implemented. Because moderate to high risk incidents are unlikely to occur in the Marine Environment and effects management measures will be in place to address such incidents, the effects of moderate to high risk incidents are not likely to be significant.

Table 14.5.3-1 Summary of Potential Moderate to High Risk Incidents that Could Affect the Marine Environment

Description of Incident	Likely Effects on the Marine Environment	Prevention and Response Measures
Large spill (e.g., 1,000 L) of diesel fuel during Construction that spills over the ground and into the marine environment	– Injury to or mortality of wildlife, including fish, marine mammals, and seabirds – Loss of marine habitat, including benthic community – Reduction of Marine Water Quality	– The Safety, Health and Environment Emergency Response Plan (SHERP) will contain a spill prevention and response plan – The Environmental Protection Plan (EPP) will also contain conditions for fuel handling and storage, including procedures for spill response – Spill kits will be available at all work sites – A spill response team will be formed and trained prior to commencement of Construction activity – Spills will be reported to the NLDEC, as required under any Project approvals granted under the *NLEPA* – Mobile storage tanks will comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act* – Fuelling or servicing of mobile equipment on-land will not be permitted within 50 m of a waterbody
Large fuel spill into the marine environment, during Construction, due to vessel-vessel or vessel-ground collision	– Injury to or mortality of wildlife, including fish, marine mammals, and seabirds – Wildlife disturbance – Loss of marine habitat – Reduced Marine Water Quality	– The SHERP will contain safety measures for vessel operation and collision prevention, as well as a spill response plan – The EPP will also contain conditions, fuel handling and storage, and the spill response plan – Project vessels will comply with the *Canada Shipping Act* – Nalcor will develop and follow the Simultaneous Operations (SIMOPS) protocol to promote safe and efficient operation of vessels working in the Strait of Belle Isle – A vessel operator awareness program will be in place to identify high potential collision areas, time of day and seasons, and marine vessel observation procedures – Notification or Project activities will be given to mariners and fisheries broadcast announcements given to the marine vessel operators

The following sections provide a description of the conditions or activities that could lead to each incident, the potential effects of the incident on the marine environment, and a description of prevention and mitigation measures that will be implemented. Additional information on each incident is provided in Chapter 5.

Large spill (1,000 L) of diesel fuel during construction that spills over the ground and into the marine environment.

Description of Incident

During Project Construction, and Operations and Maintenance, environmentally hazardous materials such as hydrocarbons (e.g., gasoline and diesel), lubricating oils and hydraulic fluid will be used. Diesel fuel for the re-fuelling of heavy equipment will be transported in a 1,000 L portable fuel storage tank. There is a potential that this fuel tank is breached due to a mishap (e.g., roll over), and that up to 1,000 L of diesel fuel spills over the ground and into the marine environment.

Likely Effects of Incident on the Marine Environment

Diesel fuel that spills over the ground and into the marine environment may have localized effects on the quality of the water in the Strait of Belle Isle or Conception Bay. The fuel spill could result in the direct mortality of benthic invertebrates and fish eggs and larvae, and seabirds) and / or the loss or alteration of marine vegetation and habitat as well as on-shore habitat used by seabirds. The effects of a diesel fuel spill are expected to be localized, but may be felt down current from the spill location. The extent of the effects would depend on the proximity of the spill to the ocean shore, amount of fuel released, and the rate of mixing in the receiving marine environment. The ability of response crews to isolate and clean up the spill may be affected by the weather (e.g., wind, wave activity).

Summary of Prevention and Response Measures

The SHERP will include specific instructions for the prevention of and response to spills or leaks of hazardous material. The EPP will also contain material handling and storage measures, traffic management protocols, and the spill response plan. Spill response kits will be maintained at all work sites, and spill kit contents will be based on the volume of fluids in use, the type of fluid, proximity to water and other relevant factors. All personnel involved in hydrocarbon transport and transfer will be trained in spill response. A Response Team will be formed, trained and will receive regular practice in "mock" responses for incidents that require co-ordinated action. Any spills in excess of the amount, concentration, level, or rate of release authorized by the NLEPA or any Project approvals granted under the NLEPA will be reported to the NLDEC, Environment Canada and the Canadian Coast Guard, as required.

All mobile storage tanks will be registered under, and comply with the Transportation of Dangerous Goods regulation SOR/2008-34, as well as the Storage and Handling of Gasoline and Associated Products Regulations, 2003, under the *Environmental Protection Act.* Records of all storage tank contents will be maintained to reconcile inventories as a check against undetected leakage. All transport vehicles, including marine vessels, will be licensed and maintained according to safety requirements. Fuelling or servicing of mobile equipment on-land will not be permitted within 50 m of a waterbody.

Large fuel spill into the marine environment, during construction, due to vessel-vessel or vessel-ground collision.

Description of Incident

The operation of marine vessels in the Strait of Belle Isle could lead to a marine incident. Vessel-vessel or vessel-ground collisions are influenced by marine traffic, weather conditions, vessel watch procedures and human factors such as fatigue. A collision between the fallpipe vessel or a material transport ship and another boat or the seabed could result in a large spill of fuel into the marine environment. The worst case scenario would involve a fully-fuelled vessel releasing all of its fuel into the sea.

Likely Effects of Incident on the Marine Environment

A large fuel spill into the marine environment may affect the quality of the water in the Strait of Belle Isle. Depending upon size, location and timing, the fuel spill could result in the direct mortality of marine wildlife (including fish, mammals, sea turtles and seabirds) and / or the loss or alteration of marine vegetation and wildlife habitat. The effects of a fuel spill may extend beyond the spill location, as the fuel is transported by wind and current. The ability of response crews to isolate and clean up the spill may be affected by the weather (e.g., wind, wave activity).

Summary of Prevention and Response Measures

The SHERP and the EPP will include safety measures for vessel operation, including the prevention of collisions. These environmental documents will also include measures for safe handling as storage of fuels, and a spill response plan. All Project personnel will be made aware of the SHERP and designated staff will receive SHERP training. Project vessels will also comply with the *Canada Shipping Act.* The potential for vessel-vessel collisions will be limited through attention to the SHERP development and implementation of Simultaneous Operations (SIMOPS) procedures and processes, and vessel operator awareness programs to identify high potential collision areas, time of day and seasons, and marine vessel observation procedures and Project vessels will also be equipped with redundant manoeuvring systems. Nalcor will also provide notification of Project activities and schedule to mariners and prepare fisheries broadcast announcements of Project activities and schedule directed at marine vessel operators in the Project area.

Summary of Assessment of Moderate to High Risk Accidents and Malfunctions

The likely effects of a large fuel spill on the Marine Environment in the Strait of Belle Isle during Project Construction or Operations and Maintenance are primarily wildlife disturbance, injury or mortality, and reduced water quality and loss of marine habitat. Nalcor will implement prevention and response mesaures as identified above. Consequently, large spills will be prevented to the extent possible, and a large spill that does occur will be dealt with quickly to reduce the spread of fuel and disturbance to the marine environment. Prevention and response measures are in place and moderate to high risk spill incidents are unlikely to occur; therefore, the effects are not likely to be significant.

14.5.4 Residual Project Effects and Significance

The environmental effects assessment framework focuses the assessment on important and likely issues and interactions and considers the overall ecological context. The framework integrally reflects ecological and socioeconomic interrelationships between VECs, others aspects of the natural and human environments, and associated Project related issues as identified in the Project interaction tables. Nalcor's attention to sustainability as fundamental to the assessment also reflects the intent to respect ecosystem integrity, including the capability of natural systems to maintain their structures and functions, and to support biological diversity; and, the EIS integrally considers the extent to which biological diversity is affected by the Project. The effects assessment for the Marine Environment considers physical and chemical characteristics of seawater and bottom substrate, flora and invertebrate fauna; that is, physical, chemical and biological ecosystem components that provide the basis of the marine habitat to support larger biological ecosystem components such as fish, marine mammals, sea turtles, and seabirds. This section summarizes the residual Project effects on the Marine Environment and their significance.

Nalcor continues to consider possible Project interactions with the Marine Environment during Project planning, and will have effects management measures in place to minimize residual Project effects on the Marine Environment during both Construction and Operations and Maintenance phases as indicated in Tables 14.5.1-1 and 14.5.1-2. Among others, these measures include adherence to existing federal legislation (e.g., *Fisheries Act*), implementing a VTMP and Safety Zone during Construction, and Nalcor's plan to continue communication with potentially affected parties, and provide compensation as appropriate. These measures and the contingency and response measures included in the EPP to address issues that do arise will help to minimize adverse interactions with the Marine Environment.

The likely residual effects of Project Construction, and Operations and Maintenance activities on Marine Fish and Fish Habitat include loss of bottom habitat and associated change in benthic community structure and biotic injury due to rock berm construction and dredging, increased seawater turbidity due to rock berm construction and dredging, and invertebrate and fish behavioural responses to various underwater sounds and operations-related electric fields and EMFs emanating from the submarine cable and shoreline electrodes. These effects will relate to less than 10% of bottom substrate, seawater and biota that occur in the RSA. The same is predicted for the effects that are unlikely to occur (e.g., changes to sediment chemistry and biotic health due to electrode electrolysis products). Therefore, the Project is not likely to result in significant adverse environmental effects on the Marine Fish and Fish Habitat VEC.

The likely effects of Project Construction, and Operations and Maintenance activities on Marine Mammals and Sea Turtles include behavioural responses to various underwater sounds and operations-related EMFs emanating from the submarine cable and shoreline electrodes, and potential temporary hearing impairment from vessel operations. These effects will relate to less than 10% of the Marine Mammals and Sea Turtles that occur in the RSA. In addition, Project activities that produce underwater sound will be most frequent and hence, most likely to cause behavioural effects during a six-month-period of the Construction phase. During this time, Marine Mammals and Sea Turtles are predicted to exhibit localized and temporary avoidance responses that will not seriously affect migration or foraging. Therefore, the Project is not likely to result in significant adverse environmental effects on the Marine Mammals and Sea Turtles VEC.

The likely effects of Project Construction, and Operations and Maintenance activities on Seabirds include limited changes in behaviour and distribution of seabirds due to habitat alteration or habitat loss at the shoreline electrode sites, temporary displacement of some foraging seabirds during Construction, and potentially some mortality resulting from seabird strandings and collisions. No detectable change to the abundance, distribution, behaviour, habitat use or nesting success of Seabirds in the RSA is predicted to occur as a result of the Project. Therefore, the Project is not likely to result in significant adverse environmental effects on the Seabirds VEC.

Table 14.5.4-1 provides a summary of the VECs selected for the Marine Environment, and the significance of the predicted effects.

Table 14.5.4-1 Summary: Significance of Effects on Marine Valued Environmental Components

VEC	Likely Significant Effect	Comment
Marine Fish and Fish Habitat	No	The effects of the Project on the Benthic Habitat, Marine Water Quality, and Marine Fish are not likely to affect more than 10% of the physical and biological components (conditions, populations, distributions or activities, e.g., feeding, spawning, and migration) at a regional scale for a period exceeding one year
Marine Mammals and Sea Turtles	No	The effects of the Project on Baleen Whales, Toothed Whales, Pinnipeds and Sea Turtles are not likely to result in changes toconditions, populations, distributions or activities affect more than 10% of Marine Mammals and Sea Turtles at a regional scale for a period exceeding one year
Seabirds	No	The effects of the Project on Migrating Shorebirds, Nesting Seabirds, and At-sea Seabirds are not expected to result in changes toconditions, populations, distributions or activities that are likely to pose serious risk to Seabirds and represent a management challenge, have duration into the long-term at a regional scale

While the Project is likely to have residual effects on the Marine Environment as represented by the VECs assessed, effects will be within the capacity of the environment. The changes to physical and biological components of the Marine Environment resulting from the Project are unlikely to affect its baseline functions over the long term such that Marine Fish, Marine Mammals and Sea Turtles are adversely affected at a regional scale for more than one year, and a serious risk is unlikely to Seabirds at a regional scale, based on the prediction that there will be no significant effects on the range of KIs associated with the Marine Environment VECs. Therefore, the residual effects on the Marine Environment are likely to be not significant.

14.5.5 Cumulative Environmental Effects

Reasonably foreseeable future projects and activities considered in the cumulative effects assessment for the Marine Fish and Fish Habitat VEC, the Marine Mammals and Sea Turtles VEC, and the Seabirds VEC included changes to the fishing activity, and ongoing marine vessel traffic in the Strait of Belle Isle and Conception Bay.

Marine Fish and Fish Habitat

All identified past and ongoing anthropogenic projects and activities have caused and will continue to cause effects on the Marine Fish and Fish Habitat VEC in the Strait of Belle Isle RSA that overlap identified effects of the Project on the VEC, particularly bottom substrate disturbance and introduction of underwater sound to the marine environment.

The overall level of contribution of the Project to cumulative effects on the Marine Fish and Fish Habitat VEC will be minimal. The cumulative effects are predicted to be not significant.

Marine Mammals and Sea Turtles

All identified past and ongoing anthropogenic projects and activities have caused and will continue to cause effects on the Marine Mammals and Sea Turtles VEC in the Strait of Belle Isle RSA that overlap identified effects of the Project on the VEC. Effects from vessel traffic would be primarily related to behavioural responses to underwater noise. Marine Mammals and Sea Turtles may experience mortality from collisions with vessels not associated with the Project. In addition, harp and hooded seals are harvested in the RSA as part of DFO-managed commercial hunt. Some Marine Mammals and possibly Sea Turtles may experience mortality as a result of fishing by-catch.

The overall level of contribution of the Project to cumulative effects on the Marine Mammals and Sea Turtles VEC will be minimal. The cumulative effects are predicted to be not significant.

Seabirds

For the Seabirds VEC, overlapping effects would be limited to marine vessel traffic within the RSA, and the related disturbance and potential for strandings.

The overall level of contribution of the Project to cumulative effects on the Seabirds VEC will be minimal. The cumulative effects are predicted to be not significant.

14.5.6 Environmental Monitoring and Follow-up

Monitoring and follow-up programs are not proposed for specific Marine Fish, Marine Mammals, Sea Turtles, and Seabirds of special conservation concern. Any adverse residual effects from Project activities are likely to be within the normal range of variability for the species potentially affected. During the Project Construction and routine inspections during Operations and Maintenance, however, Nalcor will note any incidents related to effects on Seabirds (e.g., stranding) or other marine wildlife species, and will address these issues appropriately through their adaptive management process.

In addition, as described in Section 14.2.10, planned monitoring programs will focus on the marine habitat upon which the fish species depend. These programs will be designed (as a result of HADD) in consultation with DFO and other relevant stakeholders, and conducted according to a protocol acceptable to DFO; they are expected to provide information on Project effects and effectiveness of mitigation on fish species. Programs include the following:

- monitoring of any compensation works as a result of HADD of marine fish habitat, potentially including the underwater rock berms;
- a follow-up program to evaluate the EMFs that will be generated by the operating submarine cable and electrodes; and
- a follow-up program to evaluate the level of production of electrolysis products at the electrode sites, including measurements of chemicals in the seawater and surficial sediment and biota at varying distances from the electrodes.

Also, as indicated in Section 14.2.10 and 14.3.10, Nalcor will conduct a follow-up program to verify effect predictions concerning the EMFs that will be generated by the operating submarine cable and electrodes. Findings from the program will be used to refine and optimize mitigation measures or any concerns that arise in relation to marine fish, marine mammals including species of conservation concern, as appropriate and as part of Nalcor's adaptive management process.

14.6 References

Abgrall, P., B.D. Mactavish and V.D. Moulton. 2008a. Marine Mammal and Seabird Monitoring of Orphan Basin Controlled Source Electromagnetic Survey Program, 2006-2007. LGL Limited Report Prepared for ExxonMobil Canada Ltd. St. John's, NL.

Abgrall, P., A.L. Lang and V.D. Moulton. 2008b. Marine Mammal and Seabird Monitoring of Husky Energy's 3-D Seismic Program in the Jeanne d'Arc Basin, 2006 and 2005-2006 Combined. LGL Rep. SA920. Report by LGL Limited, St. John's, NL, for Husky Energy Inc. St. John's, NL. 89 pp.

Aguilar-Soto, N., M. Johnson, P.T. Madsen, P.L. Tyack, A. Bocconcelli and J.F. Borsani. 2006. Does Intense Ship Noise Disrupt Foraging in Deep-diving Cuvier's Beaked Whales (*Ziphius cavirostris*)? Marine Mammal Science. 22(3): 690-699.

Alstom Grid. 2010. HVDC: Connecting to the Future. First Edition. Levallois-Perret Cedex, France: Alstom Grid.

AMEC (AMEC Earth and Environmental). 2010. Marine Flora, Fauna and Habitat Survey – Strait of Belle Isle Submarine Cable Crossing Corridors, 2008 and 2009. Prepared for Nalcor Energy, St. John's, NL.

AMEC. 2011a. Labrador-Island Transmission Link: Marine Flora, Fauna and Habitat Survey: Strait of Belle Isle Supplementary Report. Summary of the 2008-09 Marine Survey Results, With a Focus on the Forteau Point to Shoal Cove Cable Corridor Option. Prepared for Nalcor Energy, St. John's, NL.

AMEC. 2011b. Strait of Belle Isle: Oceanographic Environment and Sediment Modelling. Prepared for Nalcor Energy. St. John's, NL.

Anderson, D.E. 1988. Dose-response Relationship Between Human Disturbance and Brown Pelican Breeding Success. Wildlife Society Bulletin. 16: 339-245.

Anderson, D.E. and J.O. Keith. 1980. The Human Influence on Seabird Breeding Success. Biological Conservation. 18: 65-80.

Andriguetto-Filho, J.M., A. Ostrensky, M.R. Pie, U.A. Silva and W.A. Boeger. 2005. Evaluating the Impact of Seismic Prospecting on Artisanal Shrimp Fisheries. Continental Shelf Research. 25: 1720-1727.

Andrulewicz, E., D. Napierska and Z. Otremba. 2003. The Environmental Effects of the Installation and Functioning of the Submarine *SwePol Link* HVDC Transmission Line: A Case Study of the Polish Marine Area of the Baltic Sea. Journal of Sea Research. 49: 337-345.

Au, W.W.L. and M. Green. 1997. Acoustic Interaction of Humpback Whales and Whale Watching Boats off Maui, Hawaii. Journal of the Acoustical Society of America. 102(5, Pt. 2). p. 3177.

Au, W.W.L. and M. Green. 2000. Acoustic Interaction of Humpback Whales and Whale Watching Boats. Marine Environmental Research. 49(5, Jun.): 469 481.

Au, W.W.L., D.A. Carder, R.H. Penner and B.L. Scronce. 1985. Demonstration of Adaptation in Beluga Whale Echolocation Signals. Journal of the Acoustical Society of America. 77(2): 726-30.

Au, W.W.L., A.A. Pack, M.O. Lammers, L.M. Herman, M.H. Deakos and K. Andrews. 2006. Acoustic Properties of Humpback Whale Songs. Journal of the Acoustical Society of America. 120(2): 1103-1110.

Avins, L. and K.J. Lohmann. 2003. Use of Multiple Orientation Cues by Juvenile Loggerhead Sea Turtles *Caretta caretta*. The Journal of Experimental Biology. 206: 4317-4325.

Avins, L. and K.J. Lohmann. 2004. Navigation and Seasonal Migratory Orientation in Juvenile Sea Turtles. The Journal of Experimental Biology. 206: 1771-1778.

Baker, C.S. and L.M. Herman. 1989. Behavioral Responses of Summering Humpback Whales to Vessel Traffic: Experimental and Opportunistic Observations. NPS-NR-TRS-89-01. Rep. by Kewalo Basin Marine Mammal Laboratory, University of Hawaii, Honolulu, HI, for U.S. National Park Service. Anchorage, AK. 50 pp. NTIS PB90-198409.

Baker, C.S., L.M. Herman, B.G. Bays and G.B. Bauer. 1983. The Impact of Vessel Traffic on the Behavior of Humpback Whales in Southeast Alaska: 1982 Season. Report by Kewalo Basin Marine Mammal Laboratory, Honolulu, HI, for U.S. National Marine Mammal Laboratory. Seattle, WA. 30 pp. + fig., tables.

Baker, C.S., L.M. Herman, B.G. Bays and W.F. Stifel. 1982. The Impact of Vessel Traffic on the Behavior of Humpback Whales in Southeast Alaska. Report by Kewalo Basin Marine Mammal Laboratory, Honolulu, HI, for U.S. National Marine Fisheries Service. Seattle, WA. 78 pp.

Bazylinski, D.A., D.R. Schlezinger, B.H. Howes, R.B. Frankel and S.S. Epstein. 2000. Occurrence and Distribution of Diverse Populations of Magnetic Protists in a Chemically Stratified Coastal Salt Pond. Chemical Geology. 169: 319-328. DOI:10.1016/S0009-2541(00)(00211-4).

Bejder, L., A. Samuels, H. Whitehead and N. Gales. 2006. Interpreting Short-term Behavioural Responses to Disturbance with a Longitudinal Perspective. Animal Behaviour. 72: 1149-1158.

Belanger, L. and J. Bedard. 1989. Responses of Staging Greater Snow Geese to Human Disturbance. Journal of Wildlife Management. 53: 713-719.

Belanger, L. and J. Bedard. 1990. Energetic Cost of Man-induced Disturbance to Staging Snow Geese. Journal of Wildlife Management. 54: 36-41.

Berge, J.A. et al. 2000. Environmental Investigations Round electrodes for Transmission of Electric Currents in the Sea. Contaminants in Sediments from an Area (Grosøysøyla) near Kristiansand, Norway. Norwegian Institute for Water research Report No. LNR-4240-2000. Oslo, Norway. 44 p.

Berta, A., R. Racicot and T. Deméré. 2009. The Comparative Anatomy and Evolution of the Ear in *Balaenoptera mysticetes*. p. 33. In Abstracts of the 18th Biennial Conference of the Biology of Marine Mammals, Québec, Oct. 2009. 306 pp.

Blokpoel, H. and D.R.M. Hatch. 1976. Snow Geese, Disturbed by Aircraft, Crash into Power Lines. Canadian Field-Naturalist. 90: 195.

Bochert, R. and M.L. Zettler. 2004. Long-term Exposure of Several Marine Benthic Animals to Static Magnetic Fields. Bioelectromagnetics. 25: 498-502.

Bodznick, D., J. Montgomery and T.C. Tricas. 2003. Electroreception: Extracting Behaviorally Important Signals from Noise. Chapter 20. In S.P. Collins and N.J. Marshall (ed.). Sensory Processing in Aquatic Environments. Springer. P. 389-403.

Boeger, W.A., M.R. Pie, A. Ostrensky and M.F. Cardoso. 2006. The Effect of Exposure to Seismic Prospecting on Coral Reef Fishes. Brazilian Journal of Oceanography. 54(4): 235-239.

Bolton, A.B., H.R. Martins, M.L. Watali, J.C. Thomas and M.S. Marcovaldi. 1990. Loggerhead Released in Brazil Recaptured in Azores. Marine Turtle Newsletter. 48: 24.

Bolton, A.B., C. Santana and K.A. Bjorndal. 1992. Transatlantic Crossing by a Loggerhead Turtle. Marine Turtle Newsletter. 59: 7.

Bonadonna, F., C. Bajzak, S. Benhamou, K. Igloi, P. Jouventin, H. P. Lipp and G. Dell'Omo. 2005. Orientation in the Wandering Albatross: Interfering With Magnetic Perception Does Not Affect Orientation Performance. Proceedings of the Royal Society B: Biological Sciences. 272: 489-495.

Bowles, A.E., B. Tabachnick and S. Fidell. 1991. Review of the Effects of Aircraft Overflights on Wildlife. Volume 2: Technical Report. BBN Systems and Technologies. Canoga Park, CA.

Brabyn, M. and R. Frew. 1994. New Zealand Herd Stranding Sites Do Not Relate to Geomagnetic Topography. Marine Mammal Science. 10: 195-207.

Breithaupt, T. 2002. Sound Perception in Aquatic Crustaceans. In K. Wiese (ed.). The Crustacean Nervous System. Springer-Verlag, Berlin-Heidelberg, Germany. p. 548-558.

Brungs, W.A. 1973. Effects of Residual Chlorine on Aquatic Life. Journal of Water Pollution Control Federation. 176: 2180-2193.

Budelmann, B.U. 1992. Hearing in Crustacea. In D.B. Webster, R.R. Fay and A.N. Popper (ed.). Evolutionary Biology of Hearing. Springer-Verlag, New York, NY. p. 131-139.

Budelmann, B.U. and R. Williamson. 1994. Directional Sensitivity of Hair Cell Afferents in the Octopus Statocyst. Journal of Experimental Biology. 187: 245-259.

Burger, J. 1991. The Effects of Human Activity on Birds at a Coastal Bay. Biological Conservation. 21: 231-241.

Burger, J. and M. Gochfeld. 1991. Human Activity Influence and Diurnal and Nocturnal Foraging of Sanderlings (*Calidris alba*). Condor. 93: 259-265.

Cameron, I.L., K.E. Hunter and W.D. Winters. 1985. Retardation of Embryogenesis by Extremely Low Frequency 60 Hz Electromagnetic Fields. Physiological Chemistry and Physics and Medical NMR. 17: 135-138.

Cameron, I.L., W.E. Hardman, W.D. Winters, S. Zimmerman and A.M. Zimmerman. 1993. Environmental Magnetic Fields: Influences on Early Embryogenesis. Journal of Cell Biochemistry. 51: 417-425.

Canadian Electrical Association. 2010. Perspectives: Electric and Magnetic Fields. Available at: http://emf.electricity.ca/. Accessed: March 2010.

Canadian Wildlife Service. 1991. Birds Protected in Canada under the Migratory Birds Convention Act. Environment Canada Canadian Wildlife Service, Occasional Paper No. 1.

Carr, A. 1986. Rips, FADS and Little Loggerheads. Bioscience. 36: 92-100.

Carr, A. 1987. New Perspectives on the Pelagic Stage of Sea Turtle Development. Conservation Biology. 1(2): 103.

Casper, B. M. and D.A. Mann. 2006. Evoked Potential Audiograms of the Nurse Shark (*Ginglymostoma cirratum*) and the Yellow Stingray (*Urobatis jamaicensis*). Environmental Biology of Fishes. 76: 101-108.

Cawthorn, M.W. 1992. New Zealand Progress Report on Cetacean Research. Reports of the International Whaling Commission. 42: 357-360.

CCME (Canadian Council of Ministers of the Environment). 2011a. Sediment Quality Guidelines for the Protection of Aquatic Life. Available at: http://st-ts.ccme.ca/?chems=all&chapters=3. Accessed: July 2011.

CCME. 2011b. Water Quality Guidelines for the Protection of Aquatic Life. Available at: http://st-ts.ccme.ca/?chems=all&chapters=1. Accessed: July 2011.

CEA (Canadian Electrical Association). 2010. Electric and Magnetic Fields. Perspectives. Canadian Electrical Association. Ottawa, ON. 4 pp.

Chidley, G. 2000. Newfoundland and Labrador Fisher. Renews, Newfoundland and Labrador. In-person communication. September 2000.

Christian, J.R., A. Mathieu, D.H. Thomson, D. White and R.A. Buchanan. 2003. Effect of Seismic Energy on Snow Crab (*Chionoecetes opilio*). Environmental Studies Research Funds Report No. 144. Calgary, AB, Canada.

CIGRÉ Working Group. 1998. General Guidelines for the Design of Ground Electrodes for HVDC Links. 14.21 – TF2. July 1998.

Clark, C.W. 1983. Acoustical Communication and Behavior of the Southern Right Whale (*Eubalaena australis*). In R.S. Payne (ed.). Communication and Behavior of Whales. Westview Press. Boulder, CO. p. 163-198.

Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S. Van Parijs, A. Frankel and D. Ponirakis. 2010. Acoustic Masking in Marine Ecosystems as a Function of Anthropogenic Sound Sources. Report of the International Whaling Commission. SC-61-E10. 19 pp.

Conomy, J.T., J.A. Dubovsky, J.A. Collazo and J. Fleming. 1998. Do Black Ducks and Wood Ducks Habituate to Aircraft Disturbance? Journal of Wildlife Management. 62: 1135-1142.

Cook, M.L.H., R.A. Varela, J.D. Goldstein, S.D. McCulloch, G.D. Bossart, J.J. Finneran, D. Houser and A. Mann. 2006. Beaked Whale Auditory Evoked Potential Hearing Measurements. Journal of Comparative Physiology A. 192: 489-495.

Corkeron, P.J. 1995. Humpback Whales (*Megaptera novaeangliae*) in Hervey Bay, Queensland: Behaviour and Responses to Whale Watching Vessels. Canadian Journal of Zoology. 73(7): 1290- 1299.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010. Wildlife Species Search. Available at: http://www.cosewic.gc.ca/eng/sct1/index_e.cfm. Accessed: April 2010.

Croll, D.A., A. Acevedo-Gutiérrez, B. Tershy and J. Urbán-Ramírez. 2001. The Diving Behavior of Blue and Fin Whales: Is Dive Duration Shorter than Expected Based on Oxygen Stores? Comparative Biochemistry and Physiology. 129A: 797-809.

Dahlheim, M.E. 1987. Bio-acoustics of the Gray Whale (*Eschrichtius robustus*). PhD Thesis, University of British Columbia. Vancouver, B.C.

Dalen, J. and G.M. Knutsen. 1986. Scaring Effects in Fish and Harmful Effects on Eggs, Larvae and Fry by Offshore Seismic Explorations. Presented at Symposium on Underwater Acoustics, Halifax, Nova Scotia, Canada.

Davis, H. C. 1960. Effects of Turbidity-producing Materials in Sea Water on Eggs and Larvae of the Clam (*Venus* (*Mercenaria*) *mercenaria*). Biological Bulletin. 118: 48–54.

Davis, H. C. and H. Hidu. 1969. Effects of Turbidity Producing Substances in Sea Water on Eggs and Larvae of Three Genera of Bivalve Mollusks. The Veliger. 11: 316–323.

Davis, R.A., D. Thomson and C.I. Malme (LGL Ltd., King City, Ont., and Charles I. Malme, Engineering and Scientific Services, Hingham, MA). 1998. Environmental Assessment of Seismic Exploration of the Scotian Shelf. Prepared for Mobil Oil Canada Properties Ltd., Shell Canada Ltd., and Imperial Oil Ltd.

De Robertis, A., V. Hjellvik, N.J. Williamson and C.D. Wilson. 2008. Silent Ships do not always Encounter more Fish: Comparison of Acoustic Backscatter Recorded by a Noise-reduced and a Conventional Research Vessel. ICES Journal of Marine Science. 65: 623-635.

Dick, M.H. and W. Donaldson. 1978. Fishing Vessel Endangered by Crested Auklet Landings. Condor. 80: 235-236.

Diego-Rasilla, F.J., R.M. Luengo and J.B. Phillips. 2010. Light-dependent Magnetic Compass in Iberian Green Frog Tadpoles. Naturwissenschaften. 97: 1077-1088.

Dooling, R. 1980. Behaviour and Psychophysics of Hearing in Birds. In A.N. Popper and R.R. Fay (ed.). Comparative Studies of Hearing in Vertebrates. Springer-Verlag. New York, NY. p. 261-288.

Dooling, R. 2000. Hearing in birds. In D.B. Webster, R.R. Fay and A.N. Popper (ed.). The Evolutionary Biology of Hearing. Springer-Verlag. New York, NY. p. 545-559.

Doving, K.B. and O.B. Stabell. 2003. Trails in Open Water: Sensory Cues in Salmon Migration. Chapter 2. In S.P. Collins and N.J. Marshall (ed.). Sensory Processing in Aquatic Environments. Springer. p. 39-52.

Drozdowski, A. 2009. BBLT3D, the Generalized Bottom Boundary Layer Transport Model: Formulation and Preliminary Applications. Canadian Technical Report of Hydrography and Ocean Sciences 263. vi + 32 pp.

Drozdowski, A., C. Hannah and T. Tedford. 2004. BBLT Version 7.0 User's Manual. Canadian Technical Report of Hydrography and Ocean Sciences 240. vi + 69 pp.

Dufault, S. and R.A. Davis. 2003. Whale Monitoring Aboard the Cat, Summer 2002. LGL Rep. 2741. Report from LGL Ltd., King City, Ont. for Bay Ferries Ltd., Charlottetown, P.E.I. 33 pp. + Appendices.

Eckert, S.A. and H.R. Martins. 1989. Transatlantic Travel by a Juvenile Loggerhead Turtle. Marine Turtle Newsletter. 59: 7.

Emu Ltd. 2004. Subsea Cable Decommissioning-A Limited Environmental Appraisal. Report commissioned by British Telecommunications plc, Cable & Wireless and AT&T. Report No. 04/J/01/06/0648/0415, available from UKCPC.

Engås, A., E.K. Haugland and J.T. Ovredal. 1998. Reactions of Cod (*Gadus morhua* L.) in the Pre-vessel Zone to an Approaching Trawler under Different Light Conditions. Hydrobiologica. 371-372: 199-206.

Engås, A., S. Løkkeborg, A.V. Soldal and E. Ona. 1993. Comparative Trials for Cod and Haddock Using Commercial Trawl and Longline at Two Different Stock Levels. Journal of the Northwest Atlantic Fisheries Society. 19: 83-90.

Engås, A., S. Løkkeborg, E. Ona and A.V. Soldal. 1996. Effects of Seismic Shooting on Local Abundance and Catch Rates of Cod (*G. morhua*) and Haddock (*M. aeglefinus*). Canadian Journal of Fisheries and Aquatic Sciences. 53(10): 2238-2249.

Eppley, R.W., E.H. Renger and P.M. Williams. 1976. Chlorine Reactions with Seawater Constituents and the Inhibition of Photosynthesis on Natural Marine Phytoplankton. Estuarine and Coastal Marine Science. 4: 147-161.

EPRI (Electric Power Research Institute). 1981. HVDC Ground Electrode Design. Project 1467-1. August 1981.

Faugstad, K., H. Borgen, N.H. Jendal, J.E. Skog and A. Strandem. 2007a. Experience from the Licensing Process for the North Sea HVDC Interconnections. Possible Consequences for Future Submarine Links.

Faugstad, K., M. O'Brien, M. Rashwan, M. Smith Moyle and M. Zavahir. 2007b. An Environmental Survey on the Operation and Impact of HVDC Electrodes. CIGRE. Osaka 2007. 10 pp. Available at: http://www.cigre.org.

Fay, R.R. and A.N. Popper. 2000. Evolution of Hearing in Vertebrates: The Inner Ears and Processing. Hearing Research. 149(1): 1-10.

Fernandez, C. and P. Azkona. 1993. Human Disturbance Affects Parental Care of Marsh Harriers and Nutritional Status of Nestlings. Journal of Wildlife Management. 57: 602-608.

Finneran, J.J., D.S. Houser, B. Mase-Guthrie, R.Y. Ewing and R.G. Lingenfelser. 2009. Auditory Evoked Potentials in a Stranded Gervais' Beaked Whale (*Mesoplodon europaeus*). Journal of the Acoustical Society of America. 126(1): 484-490.

FJGI (Fugro Jacques GeoSurveys Inc.). 2010. Marine Habitats in the Strait of Belle Isle: Interpretation of 2007 Geophysical (Sonar) Survey Information for the Submarine Cable Crossing Corridors. Prepared for Nalcor Energy. St. John's, NL.

FJGI. 2011. Reinterpretation of 2007 Geophysical (Sonar) Survey Information for the Proposed Submarine Cable Crossing Corridor. Prepared for Nalcor Energy, St. John's, NL.

Flemming, S.P., R.D. Chaisson, R.D. Smith, P.C. Austin-Smith and R.P. Bancroft. 1988. Piping Plover Status in Nova Scotia Related to its Reproductive and Behavioural Responses to Human Disturbance. Journal of Field Ornithology. 59: 321-330.

Fletcher, J.L. 1980. Effects of Noise on Wildlife: A Review of Relevant Literature 1971-1978. Proceedings of the 3rd International Congress on Noise as a Public Health Problem. Rockville, ML. p. 611-620.

Fletcher, J.L. and R.G. Busnel (ed.). 1978. Effects of Noise on Wildlife. Academic Press Inc. New York, NY. 305 pp.

Fock, H., P. Johnassen, U. Kullnick, S. Marhold and W. Greve. 1999. Schwimmverhalten von Jungaalen in einem experimentell geänderten geomagnetischen Feld. Untersuchungen im Auftrag der HEW Hamburg. Forschungsinstitut Senkenberg, IMST, Univ. Duisburg, unpubl.: 33 p.

Foster-Smith, R. L. 1976. Some Mechanisms for the Control of Pumping Activity in Bivalves. Marine Behavioural Physiology. 4: 41–60.

Fulling, G.L. and J.C. Salinas Vega. 2009. Unique Sperm Whale (*Physeter macrocephalus*) Encounter in the Mariana Islands. In Abstracts 18th Biennial Conference of the Biology of Marine Mammals, 12–16 October 2009. Quebec City, Quebec.

Gaston, A.J., D.F. Bertram, A.W. Boyne, J.W. Chardine, G.K. Davoren, A.W. Diamond, A. Hedd, W.A. Montevecchi, J.M. Hipfner, J.F. Lemon, M.L. Mallory, J.-F. Rail and G.J. Robertson. 2009. Changes in Canadian Seabird Populations and Ecology since 1970 in Relation to Changes in Oceanography and Food Webs. Environmental Reviews. 17: 267-286.

Gilchrist, H.G. and M.L. Mallory. 2005. Declines in the Abundance and Distribution of the Ivory Gull (*Pagophila eburnea*) in Arctic Canada. Biological Conservation. 121(2): 303-309.

Gill, A.B., I. Gloyne-Phillips, K.J. Neal and J.A. Kimber. 2005. The Potential Effects of Electromagnetic Fields Generated by Sub-Sea Power Cables Associated with Offshore Wind Farm Developments on Electrically and Magnetically Sensitive Marine Organisms – A Review. Report by Cranfeld University and Centre for Marine and Coastal Studies Ltd. for COWRIE. 128 pp.

Gill, J.A., K. Norris and W.J. Sutherland. 2000. Why Behavioural Responses May Not Reflect the Population Consequences of Human Disturbance. Biological Conservation. 97(2): 265-268.

Gill, J.A., W.J. Sutherland and A.R. Watkinson. 1996. A Method to Quantify the Effects of Human Disturbance on Animal Populations. Journal of Applied Ecology. 33: 786-792.

Goff, M., M. Salmon and K.J. Lohmann. 1995. The Magnetic Compass of Loggerhead Sea Turtle Hatchlings: Calibration by Surface Waves. In Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical memorandum NMFS-SEFCS-387. p. 105.

Goff, M., M. Salmon and K.J. Lohmann. 1998. Hatchling Sea Turtles Use Surface Waves to Establish a Magnetic Compass Direction. Animal Behavior. 55: 69-77.

Gordon, J., R. Leaper, F.G.Hartley and O. Chappell. 1992. Effects of Whale-watching Vessels on the Surface and Underwater Acoustic Behaviour of Sperm Whales off Kaikoura, New Zealand. Science & Research Series No. 52, Department of Conservation, Wellington, N.Z. 64 pp.

Goss-Custard, J.D., R.T. Clarke, K.B. Briggs, B.J. Ens, K-M. Exo, C. Smit, A.J. Beintema, R.W.G. Caldow, D.C. Catt, N. Clark, S.E.A. Le V Dit Durell, M.P. Harris, J.B. Hulscher, P.L. Meininger, N. Picozzi, R. Prys-Jones, U. Safriel and A.D. West. 1995. Population Consequences of Winter Habitat Loss in Migratory Shorebirds: Estimating Model Parameters. Journal of Applied Ecology. 32: 320-336.

Goudie, R.I. 2006. Multivariate Response of Harlequin Ducks to Aircraft Disturbance in Labrador. Environmental Conservation. 33(1): 28-35.

Goudie, R.I. and I.L. Jones. 2004. Dose-response Relationships of Harlequin Duck Behaviour to Noise from Low-level Military Jet Over-flights in Central Labrador. Environmental Conservation. 31(4): 1-10.

Goulet, D.J. and G.J. Robertson. 2007. Population Trends of Shorebirds During Fall Migration in Insular Newfoundland 1980-2005. Environment Canada Atlantic Region Canadian Wildlife Service, Technical Report Series No. 473.

Green, M.L. 1998. The Impact of Vessels on the Hawaiian Humpback Whale (*Megaptera novaeangliae*): An Experimental Study, Report to the National Marine Fisheries Service of activities under permit d883. pp. 1–19.

Haine, O.S., P.V. Ridd and R.J. Rowe. 2001. Range of Electrosensory Detection of Prey by *Carcharhinus melanopterus* and *Himantura granulate*. Marine and Freshwater Research. 52: 291-296.

Halcrow, W., D.W. Mackay and I. Thorton. 1973. The Distribution of Trace Metals and Fauna in the Firth of Clyde in Relation to the Disposal of Sewage Sludge. Journal of the Marine Biological Association of the United Kingdom. 53: 721-739.

Hall, L.W., Jr., D.T. Burton and L.H. Liden. 1982. Power Plant Chlorination Effects on Estuarine and Marine Organisms. Critical Reviews in Toxicology. 10(1): 27-48.

Handegard, N.O., K. Michalsen and D. Tjostheim. 2003. Avoidance Behaviour in Cod (*Gadus morhua*) to a Bottom-trawling Vessel. Aquatic Living Resources. 16: 265-270.

Hansen, L.P. and J.A. Jacobsen. 2000. Distribution and Migration of Atlantic Salmon, *Salmo salar* L., in the Sea. In D. Mills (ed.). The Ocean Life of Atlantic Salmon. Blackwell Science, Oxford. p. 75-97.

Hassel, A., T. Knutsen, J. Dalen, K. Skaar, S. Løkkeborg, O.A. Misund, O. Ostensen, M. Fonn and E.K. Haugland. 2004. Influence of Seismic Shooting on the Lesser Sandeel (*Ammodytes marinus*). ICES Journal of Marine Science. 61(7): 1165-1173.

Hassel, A., T. Knutsen, J. Dalen, S. Løkkeborg, K. Skaar, Ø. Østensen, E.K. Haugland, M. Fonn, Å. Høines and O.A. Misund. 2003. Reaction of Sandeel to Seismic Shooting: A Field Experiment and Fishery Statistics Study. Institute of Marine Research. Bergen, Norway.

Hastings, M.C. and A.N. Popper (Jones & Stokes, Sacramento, CA). 2005. Effects of Sound on Fish. Prepared for California Department of Transportation. Sacramento, CA.

Hatch Ltd. 2011. Labrador – Island Transmission Link: Environmental Modeling: Proposed Shore Electrodes. Prepared for Nalcor Energy. St. John's, NL.

Hawkins, A. J. S., R. F. M. Smith, B. L. Bayne and M. Heral. 1996. Novel Observations Underlying the Fast Growth of Suspension-feeding Shellfish in Turbid Environments: *Mytilus edulis*. Marine Ecology Progress Series. 131: 179–190.

Hazel, J. and E. Gyuris. 2006. Vessel-related Mortality of Sea Turtles in Queensland, Australia. Wildlife Research. 33: 149-154.

Hazel, J., I.R. Lawler, H. Marsh and S. Robinson. 2007. Vessel Speed Increases Risk of Collision for the Green Turtle *Chelonia mydas*. Endangered Species Research. 3: 105-113.

Health Canada. 2010. Electric and Magnetic Fields at Extremely Low Frequencies. It's Your Health. Health Canada. Ottawa. 3 pp.

Hobson, P.A.R. and J. Hallinan. 1981. Effects of Human Disturbance on the Breeding Behaviour of Jackass Penquins (*Spheniscus demerus*). South African Journal of Wildlife Research. 11: 59-62.

Hockin, D., M. Ounsted, M. Gorman, D. Hill, V. Keller and M.A. Barker. 1992. Examination of the Effects of Disturbances on Birds with Reference to its Importance in Ecological Assessments. Journal of Environmental Management. 36: 253-286.

Horodysky, A.Z., R.W. Brill, M.L. Fine, J.A. Musick and R.J. Latour. 2008. Acoustic Pressure and Particle Motion Thresholds in Six Sciaenid Fishes. Journal of Experimental Biology. 211: 1504-1511.

Hunt, G.L. 1972. Influence of Food Distribution and Human Disturbance on the Reproductive Success of Herring Gulls. Ecology. 53: 1051-1061.

Informatics. 1980. Effects of Noise on Wildlife and Other Animals: Review of Research since 1971. National Technical Information Service, United States Department of Commerce. Springfield, Virginia.

ISO (International Organizations for Standardization). 1993. ISO 9613-1: Acoustics – Attentuation of Sound during Propoagation Outdoors – Part 1: Calculation of the Absorption of Sound by the Atmosphere. First Edition 1993. International Organization for Standardization, Geneva, Switzerland.

ISO. 1996. ISO 9613-2: Acoustics – Attenuation of Sound during Propagation Outdoors – Part 2: General Method of Calculation. First Edition 1996. International Organization for Standardization, Geneva, Switzerland.

Irwin, W.P. and K. Lohmann. 2002. Magnet-induced Distortion in Hatchling Loggerhead Sea Turtles. The Journal of Experimental Biology. 206: 497-501.

Jacques Whitford (Jacques Whitford Environment Limited) and M. Kingsley. 2000. Marine Mammals and Seabirds in the SOBI. Prepared for Newfoundland and Labrador Hydro. St. John's, NL.

Jahoda, M., C.L. Lafortuna, N. Biassoni, C. Almirante, A. Azzellino, S. Panigada, M. Zanardelli and G. Notarbartolo Di Sciara. 2003. Mediterranean Fin Whales (*Balaenoptera physalus*) Response to Small Vessels and Biopsy Sampling Assessed through Passive Tracking and Timing of Respiration. Marine Mammal Science. 19(1): 96-110.

Jasco (Jasco Applied Research). 2011a. Labrador-Island Transmission Link Sound Modeling: Proposed Strait of Belle Isle Cable Installation Activities. Prepared for Nalcor Energy. St. John's, NL.

Jasco. 2011b. Labrador-Island Transmission Link Strait of Belle Isle: Ambient Noise and Marine Mammal Survey. Prepared for Nalcor Energy. St. John's, NL.

Jeannoutot, D.W. and J.L. Adams. 1961. Progesterone Versus Treatment by High Intensity Sound as Methods of Controlling Broodiness in Broad Breasted Bronze Turkeys. Poultry Science. 40: 512-521.

Jeffs, A., N. Tolimieri and J.C. Montgomery. 2003. Crabs on Cue for the Coast: the Use of Underwater Sound for Orientation by Pelagic Crab Stages. Marine and Freshwater Research. 54: 841-845.

Jeffs, A.G., J.C. Montgomery and C.T. Tindle. 2005. How do Spiny Lobster Post-larvae Find the Coast? New Zealand Journal of Marine and Freshwater Research. 39: 605-617.

Jennings, S., M.J. Kaiser and J.D. Reynolds. 2001. Marine Fisheries Ecology. Blackwell Science, Oxford.

Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-25, National Marine Fisheries Service. Silver Spring, MD. 37 pp.

Jørgensen, R., N.O. Handegard, H. Gjøsaeter and A. Slotte. 2004. Possible vessel Avoidance Behaviour of Capelin in a Feeding Area and on a Spawning Ground. Fisheries Research. 69: 251-261.

Jungius, H. and U. Hirsch. 1979. Changes in Heartbeat Frequencies in Galapagos Nesting Birds Due to Human Disturbance. Journal of Ornithology. 120(3): 299-310.

Jurasz, C.M. and V.P. Jurasz. 1979. Ecology of Humpback Whale. Draft Report for U.S. National Park Services. Contr. No. CX-9000-7-0045.

Kaifu, K., T. Akamatsu and S. Segawa. 2008. Underwater Sound Detection by Cephalopod Statocyst. Fisheries Science. 74781-786.

Kalmijn, A.J. 1966. Electro-perception in Sharks and Rays. Nature (London). 212: 1232-1233.

Kalmijn, A.J. 1978. Experimental Evidence of Geomagnetic Orientation in Elasmobrach Fishes. In K. Schmidt-Koenig and W.T. Keeton (ed.). Animal Migration, Navigation and Homing. Heidelberg: Springer-Verlag. p. 347-353.

Kalmijn, A.J. 1982. Electric and Magnetic Field Detection in Elasmobranch Fishes. Science. 218: 916-918.

Kalmijn, A.J. 2003. Physical Principals of Electric, Magnetic, and Near-field Acoustic Orientation. Chapter 4. In S.P. Collins and N.J. Marshall (ed.). Sensory Processing in Aquatic Environments. Springer. p. 77-91.

Karoliussen, H. and R. Tunold. 1998. Seawater Electrolysis-Experimental Measurements on Skagerrak Electrodes in Grosøysøyla. NTNU-Report. Trondheim, Norway. 40 p.

Kastak, D. and R.J. Schusterman. 1998. Low-frequency Amphibious Hearing in Pinnipeds: Methods, Measurements, Noise and Ecology. Journal of the Acoustical Society of America. 103(4): 2216-2228.

Kastak, D. and R.J. Schusterman. 1999. In-air and Underwater Hearing Sensitivity of a Northern Elephant Seal (*Mirounga angustirostris*). Canadian Journal of Zoology. 77(11): 1751-1758.

Kastelein, R.A., P. Mosterd, B. van Santen, M. Hagedoorn and D. de Haan. 2002. Underwater Audiogram of a Pacific Walrus (*Odobenus rosmarus divergens*) Measured with Narrow-band Frequency-modulated Signals. Journal of the Acoustical Society of America. 112(5): 2173-2182.

Kastelein, R.A., P.J. Wensveen, L. Hoek, W.C. Verboom and J.M. Terhune. 2009. Underwater Detection of Tonal Signals between 0.125 and 100 kHz by Harbor Seals (*Phoca vitulina*). Journal of the Acoustical Society of America. 125(2): 1222-1229.

Kasuya, T. 1986. Distribution and Behaviour of Baird's Beaked Whales off the Pacific Coast of Japan. Scientific Reports of the Whales Research Institute. 37: 61-83.

Keller, O., K. Ludemann and R. Kafemann. 2006. Literature Review of Offshore Wind Farms with Regards to Fish Fauna. In Zucco, C., W. Wende, T. Merck, I. Kochling and J. Koppel (ed.). Ecological Research on Offshore Wind Farms: International Exchange of Experiences. Part B: Literature Review of Ecological Impacts. BfN-Skripten 186. p.47-129. Available at: http://www.dnl-online.de.

Ketten, D.R. 1991. The Marine Mammal Ear: Specializations for Aquatic Audition and Echolocation. In D. Webster, R. Fay and A. Popper (ed.). The Biology of Hearing. Springer-Verlag. Berlin. p. 717-750.

Ketten, D.R. 1992. The Cetacean Ear: Form, Frequency and Evolution. In J.A. Thomas, R.A. Kastelein and A. Ya Supin (ed.). Marine Mammal Sensory Systems. Plenum. New York, NY. p. 53-75.

Ketten, D.R. 1994. Functional Analysis of Whale Ears: Adaptations for Underwater Hearing. IEEE Processing Underwater Acoustics. 1: 264-270.

Ketten, D.R. 2000. Cetacean Ears. In W.W.L. Au, A.N. Popper and R.R. Fay (ed.). Hearing by Whales and Dolphins. Springer-Verlag. New York, NY. 485 pp. p. 43-108.

Keussen. 1994. Report of the Investigations at the Electrodes of the Fenno-Skan HVdc Link. Confidential Report 1/94 from PreussenElektra AG, Hannover, Germany. 5 p.

Kimbark, E.W. 1971. Direct Current Transmission, Vol. 1. Wiley Interscience, 1971.

Kirby, R. 1994. Sediments 2, Oysters 0: The Case Histories of Two Legal Disputes Involving Fine Sediments and Oysters. Journal of Coastal Research. 10: 466– 487.

Kirschvink. J.L. 1980. South Seeking Magnetic Bacteria. Journal of Experimental Biology. 86: 345-347.

Kirschvink, J.L. 1990. Geomagnetic Sensitivity in Cetaceans: An Update with Live Stranding Records in the United States. p. 639-649 In J.A. Thomas and R.A. Kastelein (ed.). Sensory Abilities of Cetaceans: Laboratory and Field Evidence. Plenum Press, New York.

Kirschvink, J.L., A.E. Dizon and J.A. Westphal. 1986. Evidence from Strandings for Geomagnetic Sensitivity in Cetaceans. Journal of Experimental Biology. 120: 1-24.

Klimley, A.P. 1993. Highly Directional Swimming by Scalloped Hammerhead Sharks, *Sphbyrna lewini*, and Subsurface Irradiance, Temperature, Bathymetry, and Geomagnetic Field. Marine Biology. 117: 1-22.

Klinowska, M. 1985. Cetacean Live Stranding Sites Relate to Geomagnetic Topography. Aquatic Mammals. 1: 27-32.

Klinowska, M. 1986. Cetacean Live Stranding Dates Relate to Geomagnetic Disturbances. Aquatic Mammals. 11(3): 109-199.

Knudson, E.I. 1980. Sound Localization in Birds. In A.N. Popper and R.R. Fay (ed.). Comparative studies of hearing in vertebrates. Springer-Verlag. New York, NY. p. 289-322.

Kojima, T., T. Suga, A. Kusano, S. Shimizu, H. Matsumoto, S. Aoki, N. Takai and T. Taniuchi. 2010. Acoustic Pressure Sensitivities and Effects of Particle Motion in Red Sea Bream *Pagrus major*. Fisheries Science. 76: 13-20.

Komak, S., J.G. Boal, L. Dickel and B.U. Budelmann. 2005. Behavioural Responses of Juvenile Cuttlefish (*Sepia officinalis*) to Local Water Movements. Marine and Freshwater Behaviour and Physiology. 38: 117-125.

Korn, J.H. and K.E. Moyer. 1966. Habituation of the Startle Response and of Heart Rate in the Rat. Canadian Journal of Psychology. 20: 183-190.

Krieger, K.J. and B.L. Wing. 1984. Hydroacoustic Surveys and Identification of Humpback Whale Forage in Glacier Bay, Stephens Passage, and Frederick Sound, Southeastern Alaska, Summer 1983. NOAA Technical Memorandum NMFS F/NWC-66. U.S. National Marine Fisheries Service. Auke Bay, AK. 60 pp. NTIS PB85-183887.

Krieger, K.J. and B.L. Wing. 1986. Hydroacoustic Monitoring of Prey to Determine Humpback Whale Movements. NOAA Technical Memorandum NMFS F/NWC-98. U.S. National Marine Fisheries Service. Auke Bay, AK. 63 pp. NTIS PB86-204054.

Kryter, K.D. 1985. The Effects of Noise on Man, 2nd ed. Academic Press. Orlando, FL. 688 pp.

Ladich, F. and A.N. Popper. 2004. Parallel Evolution in Fish Hearing Organs. In G.A. Manley, A.N. Popper, and R.R. Fay (ed.). Evolution of the Vertebrate Auditory System. Springer-Verlag, New York, NY. p. 95-127.

Lagardère, J.P. 1982. Effects of Noise on Growth and Reproduction of *Crangon crangon* in Rearing Tanks. Marine Biology. 71: 177-186.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet and M. Podesta. 2001. Collisions Between Ships and Whales. Marine Mammal Science. 17: 35-75.

Lavers, J.L., I.L. Jones, G.J. Robertson and A.W. Diamond. 2009. Contrasting Population Trends at Two Razorbill Colonies in Atlantic Canada: Additive Effects of Fox Predation and Hunting Mortality? Avian Conservation and Ecology - Écologie et conservation des oiseaux. 4(2): 3. Available at: http://www.ace-eco.org/vol4/iss2/art3/.

Lawson, J. 2011. Research Scientist. Department of Fisheries and Oceans Canada. Personal Communication via Email. 2011.

Lenhardt, M. 2002. Sea Turtle Auditory Behaviour (A). Acoustical Society of America 112(5):2314-2314.

Lesage, V., C. Barrette, M.C.S. Kingsley and B. Sjare. 1999. The Effect of Vessel Noise on the Vocal Behaviour of Belugas in the St. Lawrence River Estuary, Canada. Marine Mammal Science. 15: 65-84.

Light, P., M. Salmon and K.J. Lohmann. 1993. Geomagnetic Orientation of Loggerhead Sea Turtles: Evidence for an Inclination Compass. Journal of Experimental Biology. 182: 1-10.

Lohmann, K.J. 1991. Magnetic Orientation by Hatching Loggerhead Sea Turtles (*Caretta caretta*). Journal of Experimental Biology. 155: 37-49.

Lohmann, K.J. and A.O.D. Willows. 1987. Lunar-modulated Geomagnetic Orientation by a Marine Mollusk. Science. 235: 331-334.

Lohmann, K.J. and C.M.F. Lohmann. 1993. A Light-independent Magnetic Compass in the Leatherback Sea Turtle. Biological Bulletin. 185: 149-151.

Lohmann, K.J. and C.M.F. Lohmann. 1994a. Detection of Magnetic Inclination Angles by Sea Turtles: a Possible Mechanism for Determining Latitude. Journal of Experimental Biology. 194: 23-32.

Lohmann, K.J. and C.M.F. Lohmann. 1994b. Acquisition of Magnetic Directional Preference in Hatchling Loggerhead Sea Turtles. The Journal of Experimental Biology. 190: 1-8.

Lohmann, K.J., N.D. Pentcheff, G.A. Nevitt, G.D. Stetten, R.K. Zimmer-Faust, H.E. Jarrard and L.C. Boles. 1995. Magnetic Orientation of Spiny Lobsters in the Ocean: Experiments with Undersea Coil Systems. The Journal of Experimental Biology. 198: 2041-2048.

Lohmann, K.L. and C.M.F. Lohmann. 1996. Orientation and Open-sea Navigation in Sea Turtles. The Journal of Experimental Biology. 199: 73-81.

Løkkeborg, S. 1991. Effects of Geophysical Survey on Catching Success in Longline Fishing. Presented at the International Council for the Exploration of the Sea (ICES) Annual Science Conference. ICES CM B. 40: 1-9.

Løkkeborg, S. and A.V. Soldal. 1993. The Influence of Seismic Explorations on Cod (*Gadus morhua*) Behaviour and Catch Rates. ICES Marine Science Symposia. 196: 62-67.

Løkkeborg, S., E. Ona, A. Vold, H. Pena, A. Salthaug, B. Totland, J.T. Øvredal, J. Dalen and N.O. Handegard. 2010. Effekter av Seismiske Undersøkelser på Fiskefordeling og Fangstrater for Garn og Line i Vesterålen Sommeren 2009. (Effects of Seismic Surveys on Fish Distribution and Catch Rates of Gillnets and Longlines in Vesterålen in Summer 2009). Fisken og Havet 2-2010. 74 p. (in Norwegian with English summary).

Luschi, P., S Akesson, C. Broderick, F. Glen, B.J. Godley, F. Papi and G.C. Hays. 2001. Testing the Navigational Abilities of Ocean Migrants: Displacement Experiments on Green Sea Turtles (*Chelonia mydas*). Behavioural Ecology and Sociobiology. 50: 528-534.

Lusseau, D. 2003. Effects of Tour Boats on the Behaviour of Bottlenose Dolphins: Using Markov Chains to Model Anthropogenic Impacts. Conservational Biology. 17(6): 1785-1793.

Lusseau, D. 2004. The Hidden Cost of Tourism: Detecting Long-term Effects of Tourism using behavioural Information. Ecological Society. 9(1): 2.

Lusseau, D. 2005. The Residency Patterns of Bottlenose Dolphins (*Tursiops* spp.) have Different Strategies to Avoid Interactions with Tour Boats in Doubtful Sound, New Zealand. Marine Ecology Progress Series. 257: 265-272.

Lusseau, D., D.E. Bain, R. Williams and J.C. Smith. 2009. Vessel Traffic Disrupts the Foraging Behaviour of Southern Resident Killer Whales *Orcinus orca*. Endangered Species Research. 6: 211-221.

Lyngby, J.E. and N. Ahrensberg. 1998. Monitoring and Control Survey for the Electrode Station at Gjorslev Bøgeskov on Stevns 1997. VKI-Report Summary (Case 10990), Hørsholm, Denmark. 1-4.

Madsen, J. 1994. Impacts of Disturbance on Migratory Waterfowl. Ibis 137: S67-S74.

Magalhães, S., R. Prieto, M.A. Silva, J. Gonçalves, M. Afonso-Dian and R.S. Santos. 2002. Short-term Reactions of Sperm Whales (*Physeter macrocephalus*) to Whale-watching Vessels in the Azores. Aquatic Mammals. 28(3): 267-274.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack and J.E. Bird. 1983. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behaviour. BBN Rep. 5366. Report by Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Management Service. Anchorage, AK. Var. pag. NTIS PB86-174174.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack and J.E. Bird. 1984. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behaviour/Phase II: January 1984 Migration. BBN Rep. 5586. Report by Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Management Service. Anchorage, AK. Var. pag. NTIS PB86-218377.

Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza and A.N. Popper. 2001. Ultrasound Detection by Clupeiform Fishes**.** Journal of the Acoustical Society of America. 109(6): 3048-3054.

Mann, D.A., Z. Lu and A.N. Popper. 1997. A Clupeid Fish Can Detect Ultrasound. Nature. 389(6649): 341.

Mann, D.A., Z. Lu, M.C. Hastings and A.N. Popper. 1998. Detection of UltrasonicTtones and Simulated Dolphin Echolocation Clicks by a Teleost Fish, the American Shad (*Alosa sapidissima*). Journal of the Acoustical Society of America. 104(1): 562-568.

Manuwal, D. A. 1978. Effect of Man on Marine Birds: A Review. In C. M. Kirkpatrick (ed.). Wildlife and People: Proceedings of the John S. Wright Forestry Conference. Department of Forestry and Natural Resources and Cooperative Extension Services, Purdue University. Purdue, IN. p. 140-160.

Manzella, S.A. and C.T. Fontaine. 1988. Loggerhead Sea Turtle Travels from Padre Island, Texas to the Mouth of the Adriatic Sea. Marine Turtle Newsletter. 42: 7.

McCauley, R.D. and D.H. Cato. 2001. The Underwater Noise of Vessels in the Hervey Bay (Queensland) Whale Watch Fleet and its Impact on Humpback Whales. Journal of the Acoustical Society of America. 109(5, Pt. 2): 2455.

McCauley, R.D., D.H. Cato and A.F. Jeffery. 1996. A Study of the Impacts of Vessel Noise on Humpback Whales in Hervey Bay. Queensland, Australia: Report for the Queensland Department of Environment and Heritage, Maryborough Office, from the Department of Marine Biology, James Cook University. Townsville. 137 pp.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch and K. McCabe (Centre for Marine Science and Technology, Curtin University, Perth, Western Australia). 2000a. Marine Seismic Surveys: Analysis of Airgun Signals and Effects of Air Gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid. Prepared for Australian Petroleum Production Association. Sydney, NSW, Australia.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch and K. McCabe. 2000b. Marine Seismic Surveys – A Study of Environmental Implications. APPEA Journal. 40: 692-706.

Meisner, K. and H. Sordyl. 2006. Literature Review of Offshore Wind Farms with Regard to Benthic Communities and Habitats. In Zucco, C., W. Wende, T. Merck, I. Kochling and J. Koppel (ed.). Ecological Research on Offshore Wind Farms: International Exchange of Experiences. Part B: Literature Review of Ecological Impacts. BfN-Skripten 186. p. 1-45. Available at: http://www.dnl-online.de/suchergebnis_dnl.html.

Merkel, F.R. 2010. Light-Induced Bird Strikes on Vessels in Southwest Greenland. Greenland Institute of Natural Resources, Teknisk Rapport Pingortitaleriffik 84, 2010.

Merkel, F.R., A. Mosbech and F.F. Riget. 2009. Common Eider *Somateria mollissima* Feeding Activity and the Influence of Human Disturbances. Ardea. 97(1): 99-107.

Meyer, D.B. 1986. Avian Physiology Sense Organs: the Avian Ear and Hearing. In P.D. Sturkie (ed.). Fourth Edition. Springer-Verlag New York Inc., New York, USA. p. 48-58.

Meyer, C.G., K.N. Holland and Y.P. Papastamatiou. 2004. Sharks Can Detect Changes in the Geomagnetic Field. Journal of the Royal Society Interface. Available at: http://rsif.royalsocietypublishing.org/content/2/2/129.full.

Miles, W., S. Money, R. Luxmoore and R.W. Furness. 2010. Effects of Artificial Lights and Moonlight on Petrels at St Kilda. Bird Study. 57(2): 244-251.

Miller, P.J.O., N. Biasson, A. Samuels and P.L. Tyack. 2000. Whale Songs Lengthen in Response to Sonar. Nature. 405: 903.

Misund, O.A., J.T. Ovredal and M.T. Hafsteinsson. 1996. Reactions of Herring Schools to the Sound Field of a Survey Vessel. Aquatic Living Resources. 9: 5-11.

Moberg, G.P. 1985. Biological Response to Stress: Key to Assessing an Animal's Well-being. In Animal Stress. American Physiological Society. Bethesda, Maryland. p. 27-49.

Moberg, G.P. 1987. A Model for Assessing the Impact of Behavioural Stress on Domestic Animals. Journal of Animal Science. 65: 1228-1235.

Moein, S.E., J.A. Musick, J.A. Keinath, D.E. Barnard, M. Lenhardt and R. George. 1994. Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges. Rep. from Virginia Inst. Mar. Sci., (Gloucester Point), VA, for U.S. Army Corps of Engineers. 33 p.

Montevecchi, W.A. 2006. Influences of Artificial Light on Marine Birds. In C. Rich and T. Longcore (ed.). Ecological Consequences of Artificial Night Lighting. Island Press. Washington, D.C. p. 94-113.

Mooney, T.A., R.T. Hanlon, J. Christensen-Dalsgaard, P.T. Madsen, D.R. Ketten and P.E. Nachtigall. 2010. Sound Detection by the Longfin Squid (*Loligo pealeii*) Studied with Auditory Evoked Potentials: Sensitivity to Low-frequency Particle Motion and not Pressure. Journal of Experimental Biology. 213: 3748-3759.

Moore, F.R. 1975. Influence of Solar and Geomagnetic Stimuli on the Migratory Orientation of Herring Gull Chicks. Auk. 92: 655-664.

Moore, P.W.B. and R.J. Schusterman. 1987. Audiometric Assessment of Northern Fur Seals, *Callorhinus ursinus*. Marine Mammal Science. 3(1): 31-53.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. In W.J. Richardson (ed.). Marine Mammal and Acoustical Monitoring of WesternGeco's Open Water Seismic Program in the Alaskan Beaufort Sea, 2001. Report by LGL Ltd., King City, Ont. and Greeneridge Sciences Inc., Santa Barbara, CA, for WesternGeco, Houston, TX and National Marine Fisheries Service. Anchorage, AK and Silver Spring, MD. LGL Rep. TA2564 4. p. 31 to 348.

Moulton, V.D. and M. Holst. 2010. Effects of Seismic Survey Sound on Cetaceans in the Northwest Atlantic. Environmental Studies Research Funds Report No. 182. 28 pp.

Mulholland, R. 1984. Habitat Suitability Index Models: Hard Clam. U.S. Fish and Wildlife Service. FWS-OBS 82/10.77.

Necker, R. 2000. The avian ear and hearing. In G. Causey Whittow. Sturkie's Avian Physiology. 5th edition. Academic Press. New York, NY. p. 21-38.

Nettleship, D.N. 1980. A Guide to the Major Seabird Colonies of Eastern Canada – Identity, Distribution and Abundance. Canadian Wildlife Service, Manuscript.

Nielsen, M.R. 1986. Test Report. Sea Electrodes for Konti-Skan 2. ELSAM-Report S86/63a. 34 p.

Nisbet, I.C.T. 1977. Noise and Disturbance. In J.R. Clark (ed.). Coastal Ecosystem Management. John Wiley and Sons. New York, NY. p. 671-673.

Nisbet, I.C.T. 2000. Disturbance, Habituation, and Management of Waterbird Colonies: Commentary. Waterbirds. 23(2): 312-332.

NOAA (National Oceanic and Atmospheric Administration). 2011. Space Weather Scale for Geomagnetic Storms. Available at: http://www.swpc.noaa.gov/NOAAscales/. Accessed: September 2011.

Noren, D.P., A.H. Johnson, D. Rehder and A. Larson. 2009. Close Approaches by Vessels Elicit Surface Active Behaviours by Southern Resident Killer Whales. Endangered Species Research. 8: 179-192.

NRC (National Research Council). 2003. Ocean Noise and Marine Mammals. U.S. National Research Council. Ocean Studies Board, Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. National Academy Press. Washington, DC. 148 pp.

NRC. 2005. Marine Mammal Populations and Ocean Noise, Determining When Noise Causes Biologically Significant Effects. National Academy Press. Washington, DC. 126 pp.

Nyman, A., M. Kuussaari and M. Nielsen. 1988. Calculation and Measurements of the Stray Current Effects of Monopolar HVdc Systems. CIGRE Paper 36-03. 1988 Session.

O'Brien, M.T., M. Zavahir, M. Clark, D. Boyle and P. Milosevic. 2006. New Zealand Bipolar HVDC Earth/Sea Return Operation—Environmental Experiences. Report by Transpower New Zealand Limited. 12 pp.

Öhman, M.C., P. Sigray and H. Westerberg. 2007. Offshore Windmills and the Effects of Electromagnetic Fields on Fish. Ambio. 36: 630-633.

Ona, E., O.R. Godø, N.O. Handegard, V. Hjellvik, R. Patel and G. Pedersen. 2007. Silent Research Vessels are not Quiet. Journal of the Acoustical Society of America. 121(4): EL145-50.

OSPAR Commission. 2008. Background Document on Potential Problems Associated with Power Cables other than those for Oil and Gas Activities. 2008. OSPAR Commission Biodiversity Series.

Owens, N.W. 1977. Responses of Wintering Brent Geese to Human Disturbance. Wildfowl. 28: 5-14.

Packard, A., H.E. Karlsen and O. Sand. 1990. Low Frequency Hearing in Cephalopods. Journal of Comparative Physiology A. 166: 501-505.

Palka, D. and P.S. Hammond. 2001. Accounting for Responsive Movement in Line Transect Estimates of Abundance. Canadian Journal of Fisheries and Aquatic Science. 58: 777-787.

Papastavrou, V., S.C. Smith and H. Whitehead. 1989. Diving Behaviour of the Sperm Whale, *Physeter macrocephalus*, off the Galápagos Islands. Canadian Journal of Zoology. 67(4): 839-846.

Papi, F., P. Luschi, S. Akesson, S. Capogrossi and G.C. Hays. 2000. Open-sea Migration of Magnetically Disturbed Sea Turtles. The Journal of Experimental Biology. 203: 3435-3443.

Parks, S.E., D.R. Ketten, J.T. O'Malley and J. Arruda. 2007. Anatomical Predictions of Hearing in the North Atlantic Right Whale. Anatomical Record. 290(6): 734-744.

Parr, W., S.J. Clarke, P. van Dijk and N. Morgan. 1998. Turbidity in English and Welsh waters. Report prepared for English Nature, Report no. Co 4301/1., 116 pp. Marlow: Water Research Centre.

Parry, G.D. and A. Gason. 2006. The Effect of Seismic Surveys on Catch Rates of Rock Lobsters in Western Victoria, Australia. Fisheries Research. 79: 272-284.

Pater, L. 2001. Defining Auditory Thresholds for Animal Species. In M. Baker and G. Belliveau (ed.). Effects of Noise on Wildlife Conference. Volume 2. Terra Borealis. p. 22-25.

Payne, J.F., C.A. Andrews, L.L. Fancey, A.L. Cook and J.R. Christian. 2007. Pilot Study on the Effects of Seismic Air Gun Noise on Lobster (*Homarus americanus*). Fisheries and Oceans Canada Canadian Technical Report of Fisheries and Aquatic Sciences No. 2712.

Payne, R. 1978. Behaviour and Vocalizations of Humpback Whales (*Megaptera* sp.). In K.S Norris and R.R. Reeves (ed.). Report on a *Workshop* on *Problems Related* to *Humpback Whales* (*Megaptera novaeangliae*) in Hawaii. MCC-77/03. Report by Sea Life Inc., Makapuu Pt., HI, for U.S. Marine Mammal Commission. Washington, DC.

Pearson, W.H., J.R. Skalski and C.I. Malme. 1992. Effects of Sounds from a Geophysical Survey Device on Behaviour of Captive Rockfish (*Sebastes* spp.). Canadian Journal of Fisheries and Aquatic Sciences 49(7): 1343-1356.

Peters, K.A. and D.L. Otis. 2007. Shorebird Roost-Site Selection at Two Temporal Scales: Is Human Disturbance a Factor? Journal of Applied Ecology. 44(1): 196-209.

Pfister, C., B.A. Harrington and M. Lavine. 1992. The Impact of Human Disturbance on Shorebirds at a Migration Staging Area. Biological Conservation. 60: 115-126.

Poléo, A.B.S., H.F. Johannessen and M. Harboe Jr. 2001. High Voltage Direct Current (HVDC) Sea Cables and Sea Electrodes: Effects on Marine Life. 1st Revision of the Literature Study. Department of Biology, University of Oslo. Norway. 50pp.

Poot, H., B.J. Ens, H. de Vries, M.A.H. Donners, M.R. Wernand and J.M. Marquenie. 2008. Green Light for Nocturnally Migrating Birds. Ecology and Society. 113(2): 47. Available at: http://www.ecologyandsociety.org/vol13/iss2/art47/ES-2008-2720.pdf.

Popper, A.N. and R.R. Fay. 1999. The Auditory Periphery in Fishes. In R.R. Fay and A.N. Popper (ed.). Comparative Hearing: Fish and Amphibians. Springer-Verlag. New York, NY. p. 43-100.

Popper, A.N. and R.R. Fay. 2011. Rethinking Sound Detection by Fishes. Hearing Research. 273(1-2): 25-36.

Popper, A.N., M. Salmon and K.W. Horch. 2001. Acoustic Detection and Communication by Decapod Crustaceans. Journal of Comparative Physiology A. 187: 83-89.

Pye, H.J. and W.H. Watson, III. 2004. Sound Detection and Production in the American Lobster, *Homarus americanus*: Sensitivity Range and Behavioural Implications. Journal of the Acoustical Society of America. 115(2): 2486.

Raschi, W. and W.H. Adams. 1988. Depth-related Modifications in the Electroreceptive System of the Eurybathic Skate. *Raja radiata* (Chondrichthyes: Rajidae). Copeia. 1988(1): 116-123.

Rawizza, H.E. 1995. Hearing and Associative Learning in Cuttlefish, *Sepia officinalis*. Hopkins Marine Station Student Paper. Stanford University, Palo Alto, CA.

Reijnen, R. and R. Foppen. 1994. The Effects of Car Traffic on Breeding Bird Populations in Woodland. I. Evidence of Reduced Habitat Quality for Willow Warblers (*Phylloscopus trochilus*) Breeding Close to a Highway. Journal of Applied Ecology. 31: 85-94.

Rhoderick, J.C., R.M. Block, W.H. Roosenburg and R. Drobeck. 1977. Effects of Chlorination to the American Oyster, *Crassostrea virginica* at Two Temperatures. Association of Southeastern Biologists Bulletin. 24: 80.

Richardson, W.J. 2010. LGL Limited. Personal Communication. 2010.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA. 576 p.

Richardson, W.J., C.R. Greene, Jr., W.R. Koski, C.I. Malme, G.W. Miller, M.A. Smultea. 1990. Acoustic Effects of Oil Production Activities on Bowhead and White Whales Visible during Spring Migration near Pt. Barrow, Alaska—1989 phase. Report by LGL Ltd. for U.S. Minerals Management Service. Herdon, VA. 284 pp.

Richter, C.F., S.M. Dawson and E. Slooten. 2003. Sperm Whale Watching off Kaikoura, New Zealand: Effects of Current Activities on Surfacing and Vocalisation Patterns. Science for Conservation. 219. Dep. of Conservation. Wellington, N.Z. 78 pp.

Richter, C., S. Dawson and E. Slooten. 2006. Impacts of Commercial Whale Watching on Male Sperm Whales at Kaikoura, New Zealand. Marine Mammal Science. 22(1): 46-63.

Ridgway, S.H., E.G. Wever, J.G. Mccormick, J. Palin and J.H. Anderson. 1969. Hearing in the Giant Sea Turtle, *Chelonia mydas*. Proceedings of the National Academy of Sciences. 64: 884-890.

Ritz, T., S. Adem and K. Schulten. 2000. A model for photoreceptor-based magnetoreception in birds. Biophysical Journal 78:707-718.

Riveros, A.J and R.B. Srygley. 2010. Magnetic Compasses in Insects. Encyclopedia of Animal Behaviour. 2: 305-313.

Roberto, M., R.P. Hamerick, R.J. Salvi, D. Henderson and R. Milone. 1985. Impact Noise and the Equal Energy Hypothesis. Journal of the Acoustical Society of America. 77: 1514-1520.

Rodríguez, A. and B. Rodríguez. 2009. Attraction of Petrels to Artificial Lights in the Canary Islands: Effects of the Moon Phase and Age Class. Ibis. 151(2): 299-310.

Ryals, B.M., R.J. Dooling, E. Westbrook, M.L. Dent, A. Mackenzie and O.N. Larsen. 1999. Avian Differences in Susceptibility to Noise Exposure. Hearing Research. 131: 71-88.

Safina, C. and J. Burger. 1983. Effects of Human Disturbance on Reproductive Success of the Black Skimmer. Condor 85: 164-171.

Salden, D.R. 1993. Effects of Research Boat Approaches on Humpback Whale Behaviour off Maui, Hawaii, 1989–1993. p. 94 In Abstracts from the 10th Biennial Conference on the Biology of Marine Mammals. Galveston, TX. Nov. 1993. 130 pp.

Salmon, M. and J. Wyneken. 1987. Orientation and Swimming Behaviour of Hatchling Loggerhead Turtles (*Caretta caretta* L.) During their Offshore Migration. Journal of Experimental Marine Biology and Ecology. 109: 137-153.

Salmon, M. and K.J. Lohmann. 1989. Orientation Cues Used by Hatchling Loggerhead Sea Turtles (*Caretta caretta*) During their Offshore Migration. Ethology. 83: 215-228.

Sand, O. and H.E. Karlsen. 2000. Detection of Infrasound and Linear Acceleration in Fishes. Philosophical Transactions of the Royal Society B: Biological Sciences. 355: 1295-1298.

Sand, O., H.E. Karlsen and F.R. Knudsen. 2008. Comment on "Silent Research Vessels are not Quiet". Journal of the Acoustical Society of America. 123: 1831-1833.

Sandström, O. 1996. The Reaction of Fish to Electrode Stations established for DC Current Transmission in Water. Preliminary Report from Investigation Performed at the Fennoscand Link Anode Station at Björn, Northern Uppland. National Board of Fisheries, Institute of Coastal Research, Öregrund, Sweden. 3 p.

Sarà, G., J.M. Dean, D. D'Amato, G. Buscaino, A. Oliveri, S. Genovese, S. Ferro, G. Buffa, M.Lo Martire and S. Mazzola. 2007. Effect of Boat Noise on the Behaviour of Bluefin Tuna *Thunnus thynnus* in the Mediterranean Sea. Marine Ecology Progress Series. 331: 243-253.

Scheidat, M., C. Castro, J.Gonzalez and R. Williams. 2004. Behavioural Responses of Humpback Whales (*Megaptera novaeangliae*) to Whale Watching Boats near Isla de la Plata, Machalilla National Park, Ecuador. Journal of Cetacean Research and Management. 6: 63-68.

Schulten, K., and A. Windemuth. 1986. Model for physiological magnetic compass. In G. Maret (ed.). Biophysical Effects of Steady Magnetic Fields. Springer-Verlag, Berlin. Pages 99-106.

Schusterman, R.J., D. Kastak, D.H. Levenson, C.J. Reichmuth and B.L. Southall. 2000. Why Pinnipeds don't Echolocate. Journal of the Acoustical Society of America. 107(4): 2256-64.

Selye, H. 1950. Stress. Acta Publishing Company. Montreal, QC.

Selye, H. 1976. Forty Years of Stress Research: Principal Remaining Problems and Misconceptions. Canadian Medical Association Journal. 115(1): 53-56.

Semm, P. and R.C. Beason. 1990. Responses to small magnetic variations by the trigeminal system of the bobolink. Brain Research Bulletin 25:735-740.

Siegel, H.S. 1980. Physiological Stress in Birds. Bioscience. 30(8): 529-524.

Sikumiut (Sikumiut Environmental Management Ltd.). 2010a. Labrador – Island Transmission Link: Marine Fish and Fish Habitat in Strait of Belle Isle: Information Review and Compilation. Prepared for Nalcor Energy. St. John's, NL.

Sikumiut. 2010b. Labrador – Island Transmission Link: Marine Mammals, Sea Turtles and Seabirds in Strait of Belle Isle: Supplementary Information Review and Compilation. Prepared for Nalcor Energy. St. John's, NL.

Sikumiut. 2011a. Labrador – Island Transmission Link: Marine Water, Sediment, Benthos and Nearshore Habitat Surveys – Potential Electrode Sites. Prepared for Nalcor Energy. St. John's, NL.

Sikumiut. 2011b. Marine Water and Sediment Survey – Strait of Belle Isle Submarine Cable Crossing Corridors. Labrador – Island Transmission Link. Prepared for Nalcor Energy. St. John's, NL.

Sikumiut. 2011c. Marine Habitat and Water, Sediment and Benthic Survey: Strait of Belle Isle Cable Corridor Segment - Shoal Cove Option. Prepared for Nalcor Energy. St. John's, NL.

Skalski, J.R., W.H. Pearson and C.I. Malme. 1992. Effects of Sounds from a Geophysical Survey Device on Catch-Per-Unit-Effort in a Hook-and-Line Fishery for Rockfish (*Sebastes* spp.). Canadian Journal of Fisheries and Aquatic Science. 49(7): 1357-1365.

Söker, H., K. Rehfeldt, F. Santjer, M. Strack and M. Schreiber. 2000. Offshore Wind Energy in the North Sea. Technical Possibilities and Ecological Considerations – A Study for Greenpeace. Available at: http://archive.greenpeace.org/climate/climatecountdown/dewifinal10.pdf.

Sousa-Lima, R.S., M.E. Morete, R.C. Fortes, A.C. Freitas and M.H. Engel. 2002. Impact of Boats on the Vocal Behaviour of Humpback Whales off Brazil. Journal of the Acoustical Society of America. 112(5,Pt. 2): 2430.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals. 33(4): 411-522.

Southall, B.L., R.J. Schusterman and D. Kastak. 2000. Masking in Three Pinnipeds: Underwater, Low-frequency Critical Ratios. Journal of the Acoustical Society of America. 108(3): 1322-1326.

Southwood, A., K. Fritsches, R. Brill and Y. Swimmer. 2008. Sound, Chemical and Light Detection in Sea Turtles and Pelagic Fishes: Sensory-based Approaches to Bycatch Reduction in Longling Fisheries. Endangered Species Research. 5: 225-238.

Steimle, F., K. Foster, R. Kropp and B. Conlin. 2002. Benthic Macrofauna Productivity Enhancement by an Artificial Reef in Delaware Bay, USA. ICES Journal of Marine Science. 59: S100-S105.

Stockin, K.A., D. Lusseau, V. Binedell, N. Wiseman and M.B. Orams. 2008. Tourism Affects the Behavioural Budget of the Common Dolphin *Delphinus* sp. in the Hauraki Gulf, New Zealand. Marine Ecology Progress Series. 355: 287-295.

Suryan, R.M. and J.T. Harvey. 1999. Variability in Reactions of Pacific Harbor Seals, *Phoca vitulina richardsi*, to Disturbance. Fisheries Bulletin. 97(2): 332-339.

Sutherland, W.J. and C.W. Anderson. 1993. Predicting the Distribution of Individuals and the Consequences of Habitat Loss: the Role of Prey Depletion. Journal of Theoretical Biology. 160: 223-230.

Tarr, N.M., T.R. Simons and K.H. Pollock. 2010. An Experimental Assessment of Vehicle Disturbance Effects on Migratory Shorebirds. Journal of Wildlife Management. 74(8): 1776-1783.

Telfer, T.C., J.L. Sincock, G.V. Byrd and J.R. Reed. 1987. Attraction of Hawaiian Seabirds to Lights: Conservation Efforts and Effects of Moon Phase. Wildlife Society Bulletin. 15: 406-413.

Telstad, T. 1994. Measurements of Electric Potentials, Chlorine Content in Sea Water, and Current Distribution in the Electrode Station at Grosøyøyla PEU-memo. 6 pp. Cited in Poleo, A.B.S., H.F. Johannessen, M. Harboe Jr. 2001. High Voltage Direct Current (HVDC) Sea Cables and Sea Electrodes: Effects on Marine Life. 1st Revision of the Literature Study. Department of Biology, University of Oslo. Norway. 50 pp.

Temple, E.R., W.J. Fleming and J.A. Dubovsky. 1996. Reproduction, Growth and Survival of Captive Black Ducks Maintained in a Military Aircraft Operating Area. In W.J. Fleming, J.A. Dubovsky and J.A. Collazo (ed.). An Assessment of the Effects of Aircraft Activities on Waterfowl at Piney Island, North Carolina. North Carolina Cooperative Fish and Wildlife Research Unit. p. H1-H38.

Terhune, J.M. 1991. Masked and Unmasked Pure Tone Detection Thresholds of a Harbour Seal Listening in Air. Canadian Journal of Zoology. 69(8): 2059-2066.

Terhune, J.M. and K. Ronald. 1971. The Audiogram and Calls of the Harp Seal (*Pagophilus groenlandicus*) in Air. Proc. 7th Annual Conference on Sonar Diving Mammals. Stanford, CA, Stanford Research Institute.

Terhune, J.M. and K. Ronald. 1975. Underwater Hearing Sensitivity of Two Ringed Seals (*Pusa hispida*). Canadian Journal of Zoology. 53(3): 227-231.

Thiessen, G.J. and A.G. Shaw. 1957. Acoustic Irritation Threshold of Ring-billed Gulls. Journal of the Acoustical Society of America. 29: 1307-1309.

Thomas, K., R.G. Kvitek and C. Bretz. 2003. Effects of Human Activity on the Foraging Behaviour of Sanderlings *Calidris alba*. Biological Conservation. 109: 67-71.

Thorne, H. 2002. Newfoundland and Labrador Fisher. Thornlea, Newfoundland and Labrador. In person conversation. December 2002.

Titus, J.R. and L.W. Van Druff. 1981. Responses of the Common Loon to Recreational Pressure in the Boundary Waters Canoe Area, Northeastern Minnesota. Wildlife Monographs. 79: 3-59.

Tremblay, J. and L.N. Ellison. 1979. Effects of Human Disturbance on Breeding of Black-crowned Night Herons. Auk 96: 364-369.

Turnbull, S.D. and J.M. Terhune. 1990. White Noise and Pure Tone Masking of Pure Tone Thresholds of a Harbour Seal Listening in Air and Underwater. Canadian Journal of Zoology. 68(10): 2090-2097.

Tyack, P. 1981. Interactions Between Singing Hawaiian Humpback Whales and Conspecifics Nearby. Behavioural Ecology and Sociobiology. 8: 105-116.

Tykeson, K., A. Nyman and H. Carlsson. 1996. Environmental and Geographical Aspects in HVDC Electrode Design. IEEE Transactions on Power Delivery. 11(4): 1948-1954.

U.K. Marine SACs Project. 2011. Turbidity. Available at: http://www.ukmarinesac.org.uk/activities/water-quality/wq9_9.htm. Accessed: 20 May 2011.

Vabø, R., K. Olsen and I. Huse. 2002. The Effect of Vessel Avoidance of Wintering Norwegian Spring Spawning Herring. Fisheries Research. 58: 59-77.

Van Waerebeek, K., A.N. Baker, F. Félix, J. Gedamke, M. Iñiguez, G.P. Sanino, E. Secchi, D. Sutaria, A. van Helden and Y. Wang. 2006. Vessel Collisions with Small Cetaceans Worldwide and with Large Whales in the Southern Hemisphere; Building a Standardized Database. IWC Scientific Document SC/58/BC6.

Vanderlaan, A.S.M. and C.T. Taggart. 2007. Vessel Collisions with Whales: The Probability of Lethal Injury Based on Vessel Speed. Marine Mammal Science. 23(1): 144-156.

Vanselow, K.H. and K. Ricklefs. 2005. Are Solar Activity and Sperm Whale *Physeter macrocephalus* Strandings Around the North Sea Related? Journal of Sea Research. 53: 319-327.

Vanselow, K.H., K. Ricklefs and F. Colijn. 2009. Solar Driven Geomagnetic Anomalies and Sperm Whale (*Physeter macrocephalus*) Strandings Around the North Sea: An Analysis of Long Term Datasets. The Open Marine Biology Journal. 3: 89-94.

Vermeij, M.J.A., K.L. Marhaver, C.M. Huijbers, I. Nagelkerke and S. Simpson. 2010. Coral Larvae Move Toward Reef Sounds. PLoS ONE 5(5): e10660.

Walker, M.M. 1984. Learned Magnetic Field Discrimination in Yellowfin Tuna, *Thunnus albacares*. Journal of Comparative Physiology A. 155: 673-679.

Walker, M.M. and M.E. Bitterman. 1989. Honeybees can be trained to respond to very small changes in geomagnetic field intensity. Journal of Experimental Biology 145:489-494.

Walker, M.M., J.L. Kirschvink, G. Ahmed and A.E. Diction. 1992. Evidence that Fin Whales Respond to the Geomagnetic Field During Migration. Journal of Experimental Biology. 171: 67-78.

Wasser, S.K., K. Bevis, G. King and E. Hanson. 1997. Non-invasive Physiological Measures of Disturbance in the Northern Spotted Owl. Conservation Biology. 11: 1019-1022.

Watkins, W.A. and D. Wartzok. 1985. Sensory Biophysics of Marine Mammals. Marine Mammal Science. 1(3): 219-60.

Watmough, B. 1983. The Effects on Wildfowl of Recreation at Reservoirs in the Mid-Trent Valley, England. Severn-Trent Water Report, Birmingham. p. 1-105.

Welch, B.L and A.S. Welch. 1970. Physiological Effects of Noise. Plenum Press. New York, NY. 365 pp.

Wendt, P.H., D.M. Knott and R.F. Van Dolah. 1989. Community Structure of the Sessile Biota on Five Artificial Reefs of Different Ages. Bulletin of Marine science 44(3): 1106-1122.

Westerberg, H. 2000a. Effect of HVDC Cables on Eel Orientation. In T. Merck and H.V. Nordheim (ed.). Technische Eingriffe in Marine Lebensräume. Workshop des Bundesamtes für Naturschutz-INA Vilm 27.-29. October 1999. – BfN Skripten 29: 70-76.

Westerberg, H. and Begout-Anras. 2000. Orientation of Silver Eel (*Anguilla anguilla*) in a Disturbed Geomagnetic Field. Advances in Fish Telemetry. In A. Moore and I. Russel (ed.). Proceedings of the Third Conference on Fish Telemetry in Europe, held in Norwich, England, 20-25 June 1999. CEFAS, Lowestoft. 10 p.

Westerberg, H. and I. Lagenfelt. 2008. Sub-sea Power Cables and the Migration Behaviour of the European Eel. Fisheries Management and Ecology. 15: 369-375.

Westman, J.C. and J.R. Walters. 1981. Noise and Stress: a Comprehensive Approach. Environmental Health Perspectives. 41: 291-295.

White-Robinson, R. 1982. Inland and Saltmarsh Feeding by Wintering Brent Geese in Essex. Wildfowl. 33: 113-118.

WHO (World Health Organization). 2007. Environmental Health Criteria 238. Extremely Low Frequency Fields. World Health Organization. Geneva. 445 pp.

Wilber, D.H. and D.G. Clarke. 2001. Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. North American Journal of Fisheries Management. 21: 855-875.

Wilkerson, R. and P.E. Howse. 1975. Time Resolution of Acoustic Signals by Birds. Nature. 258: 320-321.

Williams, T.M., W.A. Friedl, M.L. Fong, R.M. Yamada, P. Sideivy and J.E. Haun. 1992. Travel at Low Energetic Cost by Swimming and Wave-riding Bottlenose Dolphins. Nature. 355(6363): 821-823.

Williams, R., D.E. Bain, J.K.B. Ford and A.W. Trites. 2002a. Behavioural Responses of Male Killer Whales to a Leapfrogging Vessel. Journal of Cetacean Research and Management. 4(3): 305-310.

Williams, R., A.W. Trites and D.E. Bain. 2002b. Behavioural Responses of Killer Whales (*Orcinus orca*) to Whale-watching Boats: Opportunistic Observations and Experimental Approaches. Journal of Zoology (London). 256: 255-270.

Wiltschko, W., and R. Wiltschko. 1995. Magnetic Orientation in Animals. Springer-Verlag, Berlin.

Wiltschko, R. and W. Wiltschko. 2009. Avian Navigation. Auk. 126: 717-743.

Wiltschko, R., D. Gehring, S. Denzau and O. Güntürkün. 2010. Interaction of Magnetite Based Receptors in the Beak with the Visual System Underling 'Fixed Direct' Responses in Birds. Frontiers in Zoology. 7: 24-29.

Worzyk, T. 2009. Submarine Power Cables. Chapter 10 Environmental Issues. Springer-Verlag. Berlin. p. 249-268.

Würsig, B., S.K. Lynn, T.A. Jefferson and K.D. Mullin. 1998. Behaviour of Cetaceans in the Northern Gulf of Mexico Relative to Survey Ships and Aircraft. Aquatic Mammas. 24(1): 41-50.

Wysocki, L.E., A. Codarin, F. Ladich and M. Picciulin. 2009. Sound Pressure and Particle Acceleration Audiograms in Three Marine Fish Species from the Adriatic Sea. Journal of the Acoustical Society of America. 126(4): 2100-2107.

Zabel, R.W., C.J. Harvey, S.L. Katz, T.P. Good and P.S. Levin. 2003. Ecologically Sustainable Yield. American Scientist. 91: 150-157.

Zimmermann, S., A.M. Zimmermann, W.D. Winters and I.L. Cameron. 1990. Influence of 60-Hz magnetic fields on sea urchin development. Bioelectromagnetics. 11: 37-45.

Nalcor Energy
Hydro Place. 500 Columbus Drive
P.O. Box 12800. St. John's. NL
Canada A1B 0C9

T. 709.737.1833 or 1.888.576.5454
F. 709.737.1985
nalcorenergy.com/lowerchurchillproject.com

nalcor energy
LOWER CHURCHILL PROJECT