FLEMISH PASS EXPLORATION DRILLING PROJECT (2018-2028)

Environmental Impact Statement

Nexen Energy ULC
March 2018



A CNOOC LIMITED COMPANY

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NEXEN ENERGY ULC
FLEMISH PASS EXPLORATION DRILLING PROJECT (2018-2028)

Environmental Impact Statement

Pursuant to the Requirements of the *Canadian Environmental Assessment Act, 2012*

FINAL REPORT

Submitted by:

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EXECUTIVE SUMMARY AND TABLE OF CONCORDANCE

Introduction and Regulatory Context

Nexen Energy ULC, a wholly-owned subsidiary of CNOOC Limited (Nexen), is planning to conduct a program of petroleum exploration drilling and associated activities in the eastern portion of the Canada-Newfoundland and Labrador Offshore Area over the period 2018 to 2028. The Project Area as assessed includes two Exploration Licences (ELs 1144 and 1150) in the Flemish Pass region for which Nexen is currently the Operator and sole interest holder, and which have not yet been subject to exploration drilling activity to date pursuant to these licences, as well as a 20 km buffer area surrounding the two licences to accommodate the location and extent of ancillary activities that may be carried out in support of such drilling activities.

The Project requires review and approval pursuant to the requirements of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). This EIS has been planned, prepared and submitted by Nexen in accordance with the requirements of CEAA 2012 as well as the Project-specific EIS Guidelines (July 2017) and other generic EA guidance documents issued by the Agency. It has also been designed and completed to address the EA requirements of the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB).

Project Overview

The objective of the Project is to determine the potential presence of hydrocarbons within the ELs offshore Eastern Newfoundland that are currently held by Nexen. The key components and activities of the Project are: exploration drilling within the two ELs identified above; possible appraisal (delineation) drilling in the event of a hydrocarbon discovery; vertical seismic profiling (VSP); well testing; eventual well abandonment or suspension procedures; and associated supply and service activities.

The scope of the Project may involve the drilling of up to 10 wells over its planned temporal duration. Specific wellsite types and locations will be selected as Project planning and design activities move forward. Wells may be drilled using either harsh environment semi-submersible or drill ship mobile offshore drilling units (MODUs), and it is possible that at times there could be two MODUs involved in Project-related drilling activities in different areas simultaneously. VSP surveys may also be conducted following completion of drilling to obtain accurate time-to-depth ties to correlate seismic data to well depth. If there is an indication of commercial hydrocarbons found during the exploration drilling program, a well flow test may be conducted to sample and identify formation fluids and to measure produced flow rates. Once completed, well abandonment or suspension activities will be undertaken. Wells will be monitored and inspected in accordance with applicable regulatory requirements.

Supply vessels and helicopters will be used to transport personnel, equipment and materials to and from the active MODU(s). Project-related supply and support activities will take place at one or more existing, established onshore facilities operated by a third-party contractor that provides services to multiple offshore operators. No Project-specific construction or expansion of such facilities or other on-shore infrastructure is required or planned.

Detailed planning and procurement processes for the Project are in progress, and will continue throughout the life of the Project. Pending the receipt of applicable regulatory and corporate approvals, the identification of suitable drilling targets and other technical, logistical and commercial considerations, exploration drilling could commence as early as 2019. It is expected that each well will require approximately 45 to 160 days for drilling and evaluation (including sidetracking and potential well testing) and associated well abandonment or suspension.

During exploration and appraisal drilling activities, sidetracking of the lower portions of the main wellbore may be required for geologic or mechanical reasons. This will be conducted by directionally drilling around obstructions in the main wellbore to either secure the original target or to intersect alternate subsurface geologic targets. Considerations such as additional time for the MODU on location as well as additional discharges associated with sidetracking have been addressed in this EIS. The 10 exploration and appraisal wells referenced above represent surface (seabed) locations and not any additional subsurface bottom hole locations associated with sidetracking from the main wellbore or subsequent sidetracked wellbores.

Environmental Assessment Scope, Approach and Methodology

The EIS provides the required information on the Project and its potential environmental effects and associated mitigation, including the:

- Project purpose;
- Project description (components, activities, schedule);
- Project alternatives;
- Changes to the Project that may be caused by the environment;
- Existing environmental setting (biophysical and socioeconomic);
- Government, stakeholder, and Indigenous engagement activities, including the various comments provided;
- Environmental effects of the Project (planned activities and potential accidental events);
- Mitigation measures to avoid or reduce environmental effects of the Project;
- Predicted residual effects and their significance;
- Predicted cumulative environmental effects; and
- Any proposed environmental monitoring and follow-up activities

In keeping with most recent EAs for other oil and gas related exploration projects offshore Newfoundland and Labrador, the following Valued Components (VCs) are considered in this assessment:

a) Marine Fish and Fish Habitat (including Species at Risk);
b) Marine and Migratory Birds (including Species at Risk);
c) Marine Mammals and Sea Turtles (including Species at Risk);
d) Special Areas;
e) Indigenous Peoples;
f) Fisheries and Other Ocean Uses; and
g) Atmospheric Environment

As a first step in assessing the potential effects of the Project on each of the selected VCs, spatial and temporal boundaries were established, within which potential Project-related environmental effects on the VC were assessed and evaluated. In order to identify and focus on key environmental issues, and to help ensure that these are fully considered and addressed in the EIS, the assessment of potential effects on each VC considers the various questions and issues that have been identified in the EIS Guidelines, as well as those identified through Nexen's engagement with relevant government departments and agencies, Indigenous groups and stakeholder organizations. The environmental effects assessment focuses on likely environmental interactions between the Project and the VC, and particularly, the associated environmental changes and resulting effects that may potentially occur.

To help avoid or reduce the potential adverse effects of the Project, general and issue-specific mitigation measures are identified and proposed in the EIS, based upon current industry practice and standards, applicable regulatory requirements, those suggested through Nexen's engagement with regulatory authorities, stakeholders and Indigenous groups, and as defined through the professional judgment of the EIS team. The application of these mitigation measures is considered in a fully integrated manner in the environmental effects assessment.

The effects assessment for each VC is structured to consider and address each planned Project component or activity and potential accidental events. The predicted (residual) environmental effects of the Project are described based on a number of standard and widely accepted environmental effects criteria or "descriptors", and concludes with a summary of the predicted residual environmental effects of the Project, and evaluates the significance of these based on VC-specific significance definitions.

Environmental Effects Assessment: Key Findings and Conclusions

As illustrated throughout this EIS, each of the potential environmental interactions, resulting environmental changes and predicted environmental effects that may be associated with the Project can be avoided or otherwise mitigated through the use of good planning and proven operational practices, which are industry standard and/or are well established and outlined in relevant regulation and guidelines, and which have been identified and committed by Nexen as part of this EIS. Additional, Project and VC-specific mitigation measures have also been identified and committed to throughout the document, as required and applicable.

Overall, the planned components and activities that will be associated with the Project will entail localized and transient disturbances in the marine environment at any one location and time period throughout the operational life of this exploration program, the potential effects of which will be effectively avoided or minimized through the various regulated or otherwise implemented mitigations referenced above. The Project is therefore not anticipated to disturb, displace, or otherwise affect marine fish, birds, mammals, sea turtles, Indigenous peoples, fisheries or other human components and activities in such a way that causes adverse, sustained and detectable effects to populations, species at risk or human activities.

The residual adverse environmental effects resulting from planned Project activities are therefore predicted to be not significant for all VCs. With the implementation of proposed mitigation measures, most environmental effects are predicted to be reversible, of short to medium duration, low to moderate magnitude, and localized geographic extent. As there are no Indigenous communities or other aspects of the physical/cultural heritage and other socioeconomic components and activities of these groups

located within or near the Project Area / Local Study Area, and because the environmental changes and effects of the Project will not likely extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse residual effects on this VC.

Nexen recognizes that of particular concern to government regulators, Indigenous groups, stakeholder organizations and the general public is the potential for an accidental event to occur during offshore drilling activities, and the potential environmental consequences of any such incident. Although each of the potential accidental events that have been assessed in the EIS (batch spills and blowouts) have the potential to adversely affect any biophysical and socioeconomic components that come into contact with them, clearly the potential for, and possible magnitude of, any such effects will depend on the specific probability, nature, degree and other characteristics of the event, including the type and amount of material spilled, its eventual geographic extent, oceanographic conditions and the persistence of these materials in the environment.

As noted through the oil spill probability analysis completed for this EIS, a blowout event is an extremely unlikely occurrence, which would be avoided through Nexen's planned spill prevention measures. If such an event were to occur, it would be acted upon quickly and effectively with Nexen's planned response measures. In addition, the subsequent (post-EA) regulatory approvals process that apply to the Project are amongst the most rigorous and stringent in the world. Through those regulatory processes, operators are required to demonstrate that they have the ability and capacity to undertake such activities in a safe and environmentally responsible manner through various project design measures, operational procedures, and response mechanisms. These mitigations will help to ensure that such an accidental event does not occur, and in the very unlikely event that one did, will allow Nexen to respond in a timely and effective manner, thereby reducing any potential environmental effects.

Residual environmental effects resulting from potential accidental events are assessed and evaluated in consideration of the modelling results and the required and committed to prevention and response measures. The residual adverse environmental effects for most VCs are predicted to be not significant, although a significant residual effect to marine and migratory birds could conceivably occur (although of very low likelihood) depending on the timing, location, and duration of a spill and the effectiveness of mitigation measures. To reduce the likelihood of accidental events, Nexen will plan and implement the Project with a priority focus on safety and spill prevention.

Nexen is committed to obtaining all required permits, approvals and authorizations for the Project, and the company and its contractors will adhere to these and all relevant regulations and guidelines in planning and implementing the Project that is the subject of this EIS. This includes the various mitigations identified and committed to in the preceding sections, the implementation and effectiveness of which will be directed, managed, and monitored in accordance with Nexen's applicable policies and procedures. Nexen will also prepare and submit EA Updates to the C-NLOPB in relation to this multi-year exploration program, that will describe the previous year's Project activities, any recent and on-going engagement activities and their outcomes, as well as outlining the proposed exploration work for the coming year and evaluating the continued applicability and validity of the EIS predictions and associated mitigations.

In conclusion, the Project represents an environmentally and socially responsible, technically feasible and economically beneficial means of conducting offshore exploration drilling and other associated

activities within Nexen's existing ELs in the Flemish Pass region. It will allow Nexen to meet its exploration and expenditure obligations under the terms of these licences, while at the same time providing important direct and indirect socioeconomic benefits to the province as well as contributing information and experience to help advance the future development of the Newfoundland and Labrador offshore oil and gas industry and the overall economy of the Atlantic region and Canada.

A Table of Concordance is provided below to demonstrate compliance with the EIS Guidelines and indicate where these requirements have been addressed in this EIS document.

EIS Guidelines Requirements	EIS Section(s)
1. INTRODUCTION	
The purpose of this document is to identify for the proponent the minimum information requirements for the preparation of an Environmental Impact Statement (EIS) for a designated project to be assessed pursuant to the Canadian Environmental Assessment Act, 2012 (CEAA 2012). This document specifies the nature, scope and extent of the information required. Part 1 of this document defines the scope of the environmental assessment (EA) and provides guidance and general instruction that must be taken into account in preparing the EIS. Part 2 outlines the information that must be included in the EIS.	All
Section 5 of CEAA 2012 describes the environmental effects that must be considered in an EA, including changes to the environment and effects of changes to the environment. The factors that are to be considered in an EA are described under section 19 of CEAA 2012. The Canadian Environmental Assessment Agency (the Agency) will use the proponent's EIS and other information received during the EA process to prepare a report that will inform the issuance of a decision statement by the Minister of Environment and Climate Change. Therefore the EIS must include a full description of the changes the project will cause to the environment that may result in adverse effects on areas of federal jurisdiction (i.e. section 5 of CEAA 2012) including changes that are directly linked or necessarily incidental to any federal decisions that would permit the project to be carried out. The EIS must also include a list of key mitigation measures that the proponent proposes to undertake in order to avoid or minimize any adverse environmental effects of the project. It is the responsibility of the proponent to provide sufficient data and analysis on potential changes to the environment to ensure a thorough evaluation of the environmental effects of the project by the Agency.	All
2. GUIDING PRINCIPLES	
2.1. Environmental assessment as a planning and decision making tool	
Environmental assessment (EA) is a process to predict environmental effects of proposed projects before they are carried out. An EA: • identifies potential adverse environmental effects; • proposes measures to mitigate adverse environmental effects; • predicts whether there will be significant adverse environmental effects, after mitigation measures are implemented; and • includes a follow-up program to verify the accuracy of the EA and the effectiveness of the mitigation measures.	All
2.2 Public participation	
One of the purposes identified in CEAA 2012 is to ensure that opportunities are provided for meaningful public participation during an EA. CEAA 2012 requires that the Agency provide the public with an opportunity to participate in the EA. For EAs led by the Agency the public has an opportunity to comment on the draft EA report. Additional opportunities for participation may also be provided.	3.0
Meaningful public participation is best achieved when all parties have a clear understanding of the proposed project as early as possible in the review process. The proponent is required to provide current information about the project to the public and especially to the communities likely to be most affected by the project.	3.0

EIS Guidelines Requirements	EIS Section(s)
2.3 Engagement with Indigenous groups	
A key objective of CEAA 2012 is to promote communication and cooperation with Indigenous peoples which includes First Nations, Inuit and Métis. The proponent is expected to engage with potentially affected groups, beginning as early as possible in the project planning process.	3.3
The proponent shall provide potentially affected groups with opportunities to learn about the project and its potential effects and to make their concerns known about the project's potential effects and discuss measures to mitigate those effects. The proponent is strongly encouraged to work with potentially affected groups to establish an engagement approach. The proponent will make reasonable efforts to integrate Aboriginal traditional knowledge into the assessment of environmental effects. For more information on incorporating Aboriginal traditional knowledge, refer to Part 1, Section 4.2.2 of these guidelines.	3.3
In order to fulfill the Crown's constitutional obligations to consult with potentially impacted groups, the Agency integrates its legal obligation for consultation and accommodation in the EA process. The information gathered by the proponent during its engagement with groups helps to contribute to the Crown's understanding of any potential adverse impacts on potential or established Aboriginal or treaty rights protected under section 35 of the Constitution Act, 1982 ("section 35 Aboriginal rights") including title and related interests, and the effectiveness of measures proposed to avoid or minimize those impacts.	3.0 12.0
2.4 Application of the precautionary approach	
In documenting the analyses included in the EIS, the proponent will demonstrate that all aspects of the project have been examined and planned in a careful and precautionary manner in order to avoid significant adverse environmental effects.	2.5 2.7 2.8 2.9
3. SCOPE OF THE ENVIRONMENTAL ASSESSMENT	
3.1 Designated project	
On April 13, 2017, Nexen Energy ULC, the proponent of the Nexen Energy ULC Flemish Pass Exploration Drilling Project, provided a project description to the Agency. Based on this project description, the Agency has determined that an EA is required under CEAA 2012 and will include the following project components and activities:	1.0 4.0
– the mobilization, operation and demobilization of Mobile Offshore Drilling Unit(s) designed for year-round operations for the drilling, testing and abandonment of up to ten wells (exploration or delineation) within exploration licences operated by Nexen Energy ULC (1144 and 1150), including consideration of any proposed safety exclusion zones. Drilling may occur in various water depths under consideration, with various types of drilling units, and with multiple drilling units operating simultaneously;	2.1 2.5 4.1
– vertical seismic profiling surveys and in-water works (e.g. well evaluation and testing) to support the specific exploration wells under consideration, but excluding surveys potentially required to support conduct of the EA (e.g. environmental baseline surveys) and surveys related to the broader delineation of resources (e.g. use of 2D high-resolution reflection seismic, sub-bottom profilers, side-scan sonar, multi-beam echosounder, magnetometers); and	2.1 2.5 4.1

EIS Guidelines Requirements	EIS Section(s)
– the loading, refuelling and operation of marine support vessels (i.e. for re-supply and transfer of materials, fuel, and equipment; on-site safety during drilling activities; and transport between the supply base and Mobile Offshore Drilling Unit(s)) and helicopter support (i.e. for crew transport and delivery of light supplies and equipment) including transportation to the Mobile Offshore Drilling Unit(s).	2.1 2.5 4.1
3.2 Factors to be considered	
Scoping establishes the parameters of the EA and focuses the assessment on relevant issues and concerns. Part 2 of this document specifies the factors to be considered in the EA, including the factors listed in subsection 19(1) of CEAA 2012:	4.1
– environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other physical activities that have been or will be carried out;	4.3 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 18.3
– the significance of the effects referred to above;	4.3 8.5 9.5 10.5 11.4 12.4 13.4 14.4 15.0 16.0 18.3
– comments from the public;	3.0 4.2
– mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project;	4.3
– the requirements of the follow-up program in respect of the project;	4.3 8.6 9.6 10.6 11.5 12.5 13.5 14.518.4
– the purpose of the project;	2.2

EIS Guidelines Requirements	EIS Section(s)
– alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;	2.10
– any change to the project that may be caused by the environment; and	4.6 17.0
– the results of any relevant regional study pursuant to CEAA 2012.	1.3
3.2.1 Changes to the environment	
Environmental effects occur as interactions between actions (the carrying out of the project or decisions made by the federal government in relation to the project) and receptors in the environment, and subsequently between components of the environment (e.g. change in water quality that may affect fish).	4.3
Under CEAA 2012, an examination of environmental effects that result from changes to the environment as a result of the project being carried out or as a result of the federal government exercising any power duty or function that would allow the project to be carried out must be considered in the EIS.	1.3 18.5
In scoping the potential changes to the environment that may occur, the proponent should consider any potential changes in the physical environment such as changes to air quality, water quality and quantity, and physical disturbance of land that could reasonably be expected to occur.	4.3
3.2.2 Valued components to be examined	
Valued components (VCs) refer to environmental biophysical or human features that may be impacted by a project. The value of a component not only relates to its role in the ecosystem, but also to the value people place on it. For example, it may have been identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance.	4.2
The proponent must conduct and focus its analysis on VCs as they relate to section 5 of CEAA 2012, including the ones identified in Section 6.3 (Part 2) of these guidelines that may be affected by changes in the environment, as well as species at risk and their critical habitat as per the requirement outlined in section 79 of the Species at Risk Act. Section 5 of CEAA 2012 defines environmental effects as:	4.2
– a change that may be caused to fish and fish habitat, marine plants and migratory birds;	4.2 8.0
– a change that may be caused to the environment on federal lands, in another province or outside Canada;	1.3 4.3 8.0-16.0
– with respect to Aboriginal peoples, an effect of any change that may be caused to the environment on: ✓ health and socio-economic conditions; ✓ physical and cultural heritage; ✓ the current use of lands and resources for traditional purposes; or ✓ any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.	3.3 12.0
– for projects requiring a federal authority to exercise a power or perform a duty or function under another Act of Parliament:	1.3 8.0-16.0

EIS Guidelines Requirements	EIS Section(s)
✓ a change, other than the ones mentioned above, that may be caused to the environment and that is directly linked or necessarily incidental to the exercise of the federal power or the performance of a duty or function; and ✓ the effect of that change, other than the effects mentioned above, on: o health and socio-economic conditions, o physical and cultural heritage, or o any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.	18.5
The list of VCs presented in the EIS will be completed according to the evolution and design of the project and reflect the knowledge acquired through public consultation and engagement with Indigenous groups. The EIS will describe what methods were used to predict and assess the adverse environmental effects of the project on these valued components.	3.0 4.2 4.3
The VCs will be described in sufficient detail to allow the reviewer to understand their importance and to assess the potential for environmental effects arising from the project activities. The EIS will provide a rationale for selecting specific VCs and for excluding any VCs or information specified in these guidelines. Challenges may arise regarding particular exclusions, so it is important to document the information and the criteria used to justify the exclusion of a particular VC or piece of information. Justification may be based on, for example, primary data collection, computer modelling, literature references, public participation or engagement with Indigenous groups, or expert input or professional judgement. The EIS will identify those VCs, processes, and interactions that either were identified to be of concern during any workshops or meetings held by the proponent or that the proponent considers likely to be affected by the project. In doing so, the EIS will indicate to whom these concerns are important (i.e. the public or Indigenous groups) and the reasons why, including environmental, cultural, historical, social, economic, recreational, and aesthetic considerations, and traditional knowledge. If comments are received on a component that has not been included as a VC, these comments will be summarized and the rationale for excluding the component will address the comments.	4.2
3.2.3 Spatial and temporal boundaries	
The spatial and temporal boundaries used in the EA may vary depending on the VC and will be considered separately for each VC, including for VCs related to the current use of lands and resources for traditional purposes by Aboriginal peoples, or other environmental effects referred to under paragraph 5(1)(c) of CEAA 2012. The proponent is encouraged to consult with the Agency, federal and provincial government departments and agencies, local government and Indigenous groups, and take into account public comments when defining the spatial and temporal boundaries used in the EIS.	4.3.1 8.1 9.1 10.1 11.1 12.1 13.1 14.1 15.1
The EIS will describe the spatial boundaries, including local and regional study areas, of each VC to be used in assessing the potential adverse environmental effects of the project and provide a rationale for each boundary. Spatial boundaries will be defined taking into account the appropriate scale and spatial extent of potential environmental effects, community knowledge and Aboriginal traditional knowledge, current or traditional land and resource use by Indigenous groups, ecological, technical, social, and cultural considerations.	2.3 2.7 4.3.1 8.1 9.1 10.1 11.1

EIS Guidelines Requirements	EIS Section(s)
	12.1 13.1 14.1 15.1 16.0
The temporal boundaries of the EA will span all phases of the project determined to be within the scope of this EA as specified under section 3.1 above. If effects are predicted after project decommissioning, this should be taken into consideration in defining boundaries. Community knowledge and Aboriginal traditional knowledge should factor into decisions around defining temporal boundaries. If the temporal boundaries do not span all phases of the project, the EIS will identify the boundaries used and provide a rationale.	2.3 2.7 4.3.1 8.1 9.1 10.1 11.1 12.1 13.1 14.1 15.1 16.0
4. PREPARATION AND PRESENTATION OF THE ENVIRONMENTAL IMPACT STATEMENT	
4.1 Guidance	
The proponent is encouraged to consult relevant Agency policy and guidance on topics to be addressed in the EIS, and to liaise with the Agency during the planning and development of the EIS. The proponent is also encouraged to consult relevant guidance from other federal departments.	1.3 4.0 15.1
Submission of regulatory and technical information necessary for federal authorities to make their regulatory decisions during the conduct of the EA is at the discretion of the proponent. Although that information is not necessary for the EA decision, the proponent is encouraged to submit it concurrent with the EIS. While the EIS must outline applicable federal authorizations required for the project to proceed, the proponent must provide information relevant to the regulatory role of the federal government. It should be noted that the issuance of these other applicable federal legislative, regulatory, and constitutional requirements is within the purview of the relevant federal authorities, and are subject to separate processes post EA decision.	1.3 1.5
4.2 Use of information	
4.2.1 Government expert advice	
Section 20 of CEAA 2012 requires that every federal authority with specialist or expert information or knowledge with respect to a project subject to an EA must make that information or knowledge available to the Agency. The Agency will advise the proponent of the availability of pertinent information or knowledge or expert and specialist knowledge received from other federal authorities or other levels of government so that it can be incorporated into the EIS.	1.3
4.2.2 Community knowledge and Aboriginal traditional knowledge	
Sub-section 19(3) of CEAA 2012 states that “the environmental assessment of a designated project may take into account community knowledge and Aboriginal traditional knowledge”. For the purposes of these guidelines, community knowledge and	3.3.2

EIS Guidelines Requirements	EIS Section(s)
Aboriginal traditional knowledge refers to knowledge acquired and accumulated by a local community or an Indigenous group.	
The proponent will incorporate into the EIS the community knowledge and Aboriginal traditional knowledge to which it has access or that is acquired through public participation and engagement with Indigenous groups, in keeping with appropriate ethical standards and obligations of confidentiality. The proponent will integrate Aboriginal traditional knowledge into all aspects of its assessment including both methodology (e.g. establishing spatial and temporal boundaries, defining significance criteria) and analysis (e.g. baseline characterization, effects prediction, development of mitigation measures).	3.3.2
Agreement should be obtained from Indigenous groups regarding the use, management and protection of their existing traditional knowledge information during and after the EA. For more information on how Aboriginal traditional knowledge can be obtained and incorporated in the preparation of the EIS, please refer to the Agency's reference guide entitled "Considering Aboriginal traditional knowledge in environmental assessments conducted under the Canadian Environmental Assessment Act, 2012".	3.3.2
4.2.3 Existing information	
In preparing the EIS, the proponent can use existing information relevant to the project, if applicable. When relying on existing information to meet requirements of the EIS Guidelines, the proponent will either include the information directly in the EIS or clearly direct the reader to where it may obtain the information (i.e. through cross-referencing). When relying on existing information to support the effects assessment, the proponent will provide a rationale to support the use of the information in relation to the specific project (separate factual lines of evidence from inference), and state any limitations on the inferences or conclusions that can be drawn from the existing information. In such circumstances, the proponent will clearly describe potential or known data or knowledge gaps, and describe how such gaps have been addressed in the assessment of the project.	5.0 6.0 7.0
4.2.4 Confidential information	
In implementing CEAA 2012, the Agency is committed to promoting public participation in the EA of projects and providing access to the information on which EAs are based. All documents prepared or submitted by the proponent or any other stakeholder in relation to the EA are included in the Canadian Environmental Assessment Registry and made available to the public on request. For this reason, the EIS will not contain information that: ✓ is sensitive or confidential (i.e. financial, commercial, scientific, technical, personal, cultural or other nature), that is treated consistently as confidential, and the person affected has not consented to the disclosure; or ✓ may cause substantial harm to a person or specific harm to the environment through its disclosure. The proponent will consult with the Agency regarding whether specific information requested by these guidelines should be treated as confidential.	
4.3 Study strategy and methodology	
The proponent is expected to respect the intent of these guidelines and to consider the environmental effects that are likely to arise from the project (including situations not explicitly identified in these guidelines), the technically and economically feasible	4.0

EIS Guidelines Requirements	EIS Section(s)
mitigation measures that will be applied, and the significance of any residual effects. Except where specified by the Agency, the proponent has the discretion to select the most appropriate methods to compile and present data, information and analysis in the EIS as long as they are justifiable and replicable.	
It is possible these guidelines may include matters which, in the judgement of the proponent, are not relevant or significant to the project. If such matters are omitted from the EIS, the proponent will clearly indicate it in the EIS, and provide a justification so the Agency, federal authorities, Indigenous groups, the public and any other interested party have an opportunity to comment on this decision. Where the Agency disagrees with the proponent's decision, it will require the proponent to provide the specified information.	2.1 4.1 4.2
The assessment will include the following general steps: ✓ identifying the activities and components of the project; ✓ predicting potential changes to the environment; ✓ predicting and evaluating the likely effects on identified VCs; ✓ identifying technically and economically feasible mitigation measures for any significant adverse environmental effects; ✓ determining any residual environmental effects; ✓ considering cumulative effects of the project in combination with other physical activities that have been or will be carried out; and ✓ determining the potential significance of any residual environmental effect following the implementation of mitigation measures.	2.0 4.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0
For each VC, the EIS will describe the methodology used to assess project-related effects. The EIS could include an analysis of the pathway of the effects of environmental changes on each VC. The EIS will document where and how scientific, engineering, community knowledge and Aboriginal traditional knowledge were used to reach conclusions. Assumptions will be clearly identified and justified. All data, models and studies will be documented such that the analyses are transparent and reproducible. All data collection methods will be specified. The uncertainty, reliability, sensitivity and conservativeness of models used to reach conclusions must be indicated.	4.0
The EIS will identify all significant gaps in knowledge and understanding related to key conclusions, and the steps to be taken by the proponent to address these gaps. Where the conclusions drawn from scientific, engineering and technical knowledge are inconsistent with the conclusions drawn from Aboriginal traditional knowledge, the EIS will present each perspective on the issue and a statement of the proponent's conclusions.	4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0
The EIS will include a description of the environment (both biophysical and human), including the components of the existing environment and environmental processes, their interrelations as well as the variability in these components, processes and interactions over time scales appropriate to the likely effects of the project. The description will be sufficiently detailed to characterize the environment before any disturbance to the	5.0 6.0 7.0

EIS Guidelines Requirements	EIS Section(s)
environment due to the project and to identify, assess and determine the significance of the potential adverse environmental effects of the project. These data should include results from studies done prior to any physical disruption of the environment due to project related activities. The information describing the existing environment may be provided in a stand-alone chapter of the EIS or may be integrated into clearly defined sections within the effects assessment of each VC. This analysis will include environmental conditions resulting from historical and present activities in the local and regional study areas.	
If the baseline data have been extrapolated or otherwise manipulated to depict environmental conditions in the study areas, modelling methods and equations will be described and will include calculations of margins of error and other relevant statistical information, such as confidence intervals and possible sources of error. The proponent will provide the references used in creating their approach to baseline data gathering, including identifying where appropriate, the relevant federal or provincial standards. The proponent is encouraged to discuss the timeframe and considerations for its proposed baseline data with the Agency prior to submitting its EIS.	5.0 6.0 7.0
In describing and assessing effects to the physical and biological environment, the proponent will take an ecosystem approach that considers both scientific and community knowledge and Aboriginal traditional knowledge and perspectives regarding ecosystem health and integrity. The proponent will consider the resilience of relevant species populations, communities and their habitats. The assessment of environmental effects on Aboriginal peoples, pursuant to paragraph 5(1)(c) of CEAA 2012, will undergo the same rigour and type of assessment as any other VC (including setting of spatial and temporal boundaries, identification and analysis of effects, identification of mitigation measures, determination of residual effects, identification and a clear explanation of the methodology used for assessing the significance of residual effects and assessment of cumulative effects).	4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0
The proponent will consider the use of both primary and secondary sources of information regarding baseline information, changes to the environment and the corresponding effect on health, socio-economics, physical and cultural heritage and the current use of lands and resources for traditional purposes. Primary sources of information could include traditional land use studies, socio-economic studies, heritage surveys or other relevant studies conducted specifically for the project and its EIS. Often these studies and other types of relevant information are obtained directly from Indigenous groups. Secondary sources of information could include previously documented information on the area, not collected specifically for the purposes of the project, or desk-top or literature-based information. The proponent will provide Indigenous groups the opportunity to review and provide comments on the information used for describing and assessing effects on Aboriginal peoples (further information on engaging with Indigenous groups is provided in Part 2, Section 5 of this document). Where there are discrepancies in the views of the proponent and Indigenous groups on the information to be used in the EIS, the EIS will document these discrepancies and the rationale for the proponent's selection of information.	5.0 6.0 7.0
The assessment of the effects of each of the project components and physical activities, in all phases, will be based on a comparison of the biophysical and human environments between the predicted future conditions with the project and the predicted future	4.3 5.0 6.0

EIS Guidelines Requirements	EIS Section(s)
conditions without the project. In undertaking the environmental effects assessment, the proponent will use best available information and methods. All conclusions will be substantiated. Predictions will be based on clearly stated assumptions. The proponent will describe how each assumption has been tested. With respect to quantitative models and predictions, the EIS will document the assumptions that underlie the model, the quality of the data and the degree of certainty of the predictions obtained.	7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0
4.4 Presentation and organization of the environmental impact statement	
To facilitate the identification of the documents submitted and their placement in the Canadian Environmental Assessment Registry, the title page of the EIS and its related documents will contain the following information: – project name and location – title of the document, including the term “environmental impact statement” – subtitle of the document – name of the proponent – date of submission of the EIS	Cover Page
The EIS will be written in clear, precise language. A glossary defining technical words, acronyms and abbreviations will be included. The EIS will include charts, diagrams, tables, maps and photographs, where appropriate, to clarify the text. Perspective drawings that clearly convey the various components of the project will also be provided. Wherever possible, maps will be presented in common scales and datum to allow for comparison and overlay of mapped features.	All List of Acronyms and Abbreviations
For purposes of brevity and to avoid repetition, cross-referencing within the EIS is preferred. For example, the EIS may make reference to information that has already been presented in other sections of the document, rather than repeating it. Detailed studies (including all relevant and supporting data and methodologies) will be provided in separate appendices and will be referenced by appendix, section and page in the text of the main document. The EIS will explain how information is organized in the document. This will include a table of contents with a list of all tables, figures, and photographs referenced in the text. A complete list of supporting literature and references will also be provided. A table of concordance, which cross references the information presented in the EIS with the information requirements identified in the EIS Guidelines, will be provided. The proponent will provide copies of the EIS and its summary for distribution, including paper and electronic versions in an unlocked, searchable PDF format, as directed by the Agency.	All 1.4
4.5 Summary of the environmental impact statement	
The proponent will prepare a summary of the EIS in both of Canada’s official languages (French and English) to be provided to the Agency at the same time as the EIS that will include the following: – a concise description of all key components of the project and related activities; – a summary of the engagement with Indigenous groups, and the participation of the public and government agencies, including a summary of the issues raised and the proponent’s responses;	EIS Summary Documents (submitted separately)

EIS Guidelines Requirements	EIS Section(s)
– an overview of expected changes to the environment; – an overview of the key environmental effects of the project, as described under section 5 of CEAA 2012, and proposed technically and economically feasible mitigation measures; – an overview of how factors under paragraph 19(1) of CEAA 2012 were considered; – the proponent's conclusions on the residual environmental effects of the project, and the significance of those effects, after taking into account the mitigation measures.	
The summary is to be provided as a separate document and should be structured as follows:	EIS Summary Documents (submitted separately)
1. Introduction and EA context	
2. Project overview	
3. Alternative means of carrying out the project	
4. Public participation	
5. Engagement with Indigenous Groups	
6. Summary of environmental effects assessment for each valued component, including: a. description of the baseline b. anticipated changes to the environment c. anticipated effects d. mitigation measures e. significance of residual effects	
7. Follow-up and monitoring programs proposed	
The summary will have sufficient details for the reader to understand the project, any potential environmental effects, proposed mitigation measures, and the significance of the residual effects. The summary will include key maps illustrating the project location and key project components.	
Part 2 – Content of the Environmental Impact Statement	
1. INTRODUCTION AND OVERVIEW	
1.1 The proponent	
In the EIS, the proponent will: – provide contact information (e.g. name, address, phone, fax, email); – identify itself and the name of the legal entity(ies) that would develop, manage, and operate the project; – describe corporate and management structures; – specify the mechanism used to ensure that corporate policies will be implemented and respected for the project; and – identify key personnel, contractors, and/or sub-contractors responsible for preparing the EIS.	1.1 1.4 Appendix A
1.2 Project overview	
The EIS will describe the project, key project components and associated activities,	1.2

EIS Guidelines Requirements	EIS Section(s)
scheduling details, the timing of each phase of the project and other key features. If the project is part of a larger sequence of projects, the EIS will outline the larger context. The overview is to identify the key components of the project, rather than providing a detailed description, which will follow in Section 3 below.	2.0
1.3 Project location	
The EIS will contain a description of the geographical setting in which the project will take place. This description will focus on those aspects of the project and its setting that are important in order to understand the potential environmental effects of the project. The following information will be included:	
– the Universal Transverse Mercator (UTM) projection coordinates of the main project site;	1.2.1 2.3
– current land and resource use in the area;	1.2.3 2.4
– distance of the project facilities and components to any federal lands;	1.2 7.3.5
– the environmental significance and value of the geographical setting in which the project will take place and the surrounding area;	1.2.3
– environmentally sensitive areas, such as national, provincial and regional parks, ecological reserves, ecologically and biologically significant areas, fishery closure areas, vulnerable marine ecosystems, and habitats of federally or provincially listed species at risk and other sensitive areas;	1.2.3
– description of local and Indigenous communities; and	1.2.3 7.4
– traditional territories and/or consultation areas, treaty lands, and Indian Reserve lands.	1.2.3 7.4
1.4 Regulatory framework and the role of government	
The EIS will identify:	
– any federal power, duty or function that may be exercised that would permit the carrying out (in whole or in part) of the project or associated activities;	1.3 18.5
– legislation and other regulatory approvals that are applicable to the project at the federal, provincial, regional and municipal levels;	1.3 18.5
– government policies, resource management plans, planning or study initiatives pertinent to the project and/or EA and their implications;	1.3 18.5
– any treaty, self-government or other agreements between federal or provincial governments and Indigenous groups that are pertinent to the project and/or EA;	1.3 7.4 12.3
– any relevant land use plans, or land zoning; and	1.3
– regional, provincial and/or national objectives, standards or guidelines that have been used by the proponent to assist in the evaluation of any predicted environmental effects.	1.3 4.3

EIS Guidelines Requirements	EIS Section(s)
2. PROJECT JUSTIFICATION AND ALTERNATIVES CONSIDERED	
2.1 Purpose of the project	
The EIS will describe the purpose of the project by providing the rationale for the project, explaining the background, the problems or opportunities that the project is intended to satisfy and the stated objectives from the perspective of the proponent. If the objectives of the project are related to broader private or public sector policies, plans or programs, this information will also be included.	2.2
The EIS will also describe the predicted environmental, economic and social benefits of the project. This information will be considered in assessing the justifiability of any significant adverse residual environmental effects as defined in section 5 of CEAA 2012, if such effects are identified.	2.2
2.2 Alternative means of carrying out the project	
The EIS will identify and consider the environmental effects of alternative means of carrying out the project that are technically and economically feasible.	2.10
The proponent will complete the following procedural steps for addressing alternative means: - Identify the alternative means to carry out the project. - Identify the effects of each technically and economically feasible alternative means. - Select the approach for the analysis of alternative means (i.e. identify a preferred means or bring forward alternative means). - Assess the environmental effects of the alternative means.	2.10
In its alternative means analysis, the proponent will address, at a minimum, the following project components: – choice of drilling fluid (i.e. water-based drilling mud or synthetic-based drilling mud); – choice of drilling unit (i.e. drillship or semi-submersible); – management of drilling wastes (i.e. disposal on seabed or into water column, recover and ship to shore, re-inject); – water management and location of the final effluent discharge points; – alternative ways to light the platform at night to reduce attraction and associated mortality of birds; and – alternative ways to flare at night when testing the well to reduce attraction and associated mortality of birds	2.10
The Offshore Waste Treatment Guidelines include minimum performance targets for concentrations and volumes of waste material in discharges resulting from offshore exploration and development. Offshore operators are expected to take all reasonable measures to minimize the volumes of waste materials generated by their operations, and to minimize the quantity of substances of potential environmental concern contained within these waste materials. The EIS should include a discussion on how wastes and potential associated toxic substances would be minimized. The proponent should also discuss any alternatives that would enable it to achieve these objectives and adopt best practices in waste management and treatment.	1.5 2.9
The Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands provide a framework for the selection of chemicals in support of offshore operations.	1.5 2.9

EIS Guidelines Requirements	EIS Section(s)
The guidelines outline minimum expectations on the selection of lower toxicity chemicals; recognizing that variations to the selection process described in the guidelines may be required in areas where increased risk to the environment has been identified. With the objective of minimizing potential environmental impacts of discharges to the marine environment, the proponent should identify the quantity and type of chemicals (or constituents) that may be used in support of the proposed project that are: – included on the Canadian Environmental Protection Act's List of Toxic Substances; – not included on the OSPAR Pose Little or No Risk to the Environment (PLONOR) list of chemicals and have a PARCOM Offshore Chemical Notification Scheme Hazard Rating of A, B or purple, orange, blue, or white; or – not included on the PLONOR list of chemicals and have not been assigned a PARCOM Offshore Chemical Notification Scheme Hazard Rating.	2.10.7
Alternatives to the use of the above-listed chemicals (e.g. through alternative means of operating or use of less-toxic alternatives) should be discussed in the EIS.	2.9 2.10.7
For further information regarding the "purpose of" and "alternative means", please consult the Agency's Operational Policy Statement entitled "Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012".	2.2 2.10
The Agency recognizes that projects may be in the early planning stages when the EIS is being prepared. Where the proponent has not made final decisions concerning the placement of project infrastructure, the technologies to be used, or that several options may exist for various project components, the proponent shall conduct an environmental effects analysis at the same level of detail for each of the various options available (alternative means) within the EIS.	2.5 2.10
3. PROJECT DESCRIPTION	
3.1 Project components	
The EIS will describe the project, by presenting the project components, associated and ancillary works, and other characteristics that will assist in understanding the environmental effects. This will include:	2.0
– maps, at an appropriate scale, of the project location; – project components; – boundaries and UTM coordinates of the proposed exploration licences (1144 and 1150); – the major existing infrastructure; – adjacent land and resource uses; and – any important environmental features.	2.3 2.4 2.5
If the project is part of a larger sequence of projects, the proponent will outline the larger context and present the relevant references, if available.	2.2
In its EIS, the proponent will describe:	
– the Mobile Offshore Drilling Unit(s) and/or drillships and their operations (drilling, testing, abandonment) in locations and water depths under consideration;	2.5.1
– the size and types of vessels that will be used including navigation activities (i.e. routes, number and frequency of trips) and icebreaking activities (time of year, frequency, duration, expected start and end dates);	2.5.2

EIS Guidelines Requirements	EIS Section(s)
– helicopters, including routes, number and frequency of trips;	2.5.2
– vertical seismic profiling or any other in-water works (e.g. well evaluation and testing) to support the specific wells under consideration, but excluding surveys potentially required to support the conduct of the EA (e.g. environmental baseline surveys) and surveys related to the broader delineation of resources (e.g. use of 2D high-resolution reflection seismic, sub-bottom profilers, side-scan sonar, multi-beam echosounder, magnetometers);	2.5.2
– reagent requirements and uses (e.g. volumes, storage, types);	2.9
– petroleum products (e.g. source, volume, storage, oil composition and physical characteristics);	2.9
– the nature, composition and fate (e.g. areal extent) of drilling wastes (e.g. muds, cuttings) at various water depths and at various stages of drilling, including during riserless drilling and drilling with the marine riser in place, using dispersion modeling;	2.9.2 2.10 8.3.4 Appendix D
– the management or disposal of wastes (e.g. type and constituents of waste, quantity, treatment and method of disposal) including: ✓ drilling muds, drill solids; ✓ bilge and ballast water; ✓ deck drainage; ✓ cooling water; ✓ fire control system test water; ✓ operational discharges from subsea systems and the installation of subsea systems; ✓ sewage and food wastes; ✓ well treatment or testing fluids; and ✓ other operational discharges.	2.9
– contributions to atmospheric emissions, including emissions profile (i.e. type, rate and source) for activities including routine or upset flaring (including the contribution from any produced fluids that may be added to any flares), routine drilling, testing, shipping etc.;	2.9.1 14.0
– sources and extent of light, heat and noise;	2.9.1 14.0
– transfers of bulk materials (e.g. mud) and fuel;	2.5.2
– number of employees and transportation of employees;	2.5.2 2.6
– drinking and industrial water requirements (source, quantity required, need for water treatment);	
– energy supply (source, quantity); and	2.5.1 14.3
– waste disposal (types of waste, methods of disposal, quantity).	2.9
3.2 Project activities	
The EIS will include descriptions of the drilling, testing and decommissioning, suspension	2.0

EIS Guidelines Requirements	EIS Section(s)
or abandonment of wells associated with the proposed project.	
This will include descriptions of the activities to be carried out during each phase, the location of each activity, expected outputs and an indication of the activity's magnitude and scale. Water depths for potential drill sites will be specified.	2.5
Although a complete list of project activities should be provided, the emphasis will be on activities with the greatest potential to have environmental effects. Sufficient information will be included to predict environmental effects and address concerns identified by the public and Indigenous groups. Highlight activities that involve periods of increased environmental disturbance or the release of materials into the environment.	2.5
The EIS will include a summary of the changes that have been made to the project since originally proposed, including the benefits of these changes to the environment, Indigenous groups, and the public.	2.8
The EIS will include a schedule including time of year, frequency, and duration for all project activities.	2.7
The information will include a description of:	
3.2.1 Drilling and testing activities	
– operation of the Mobile Offshore Drilling Unit(s) and/or drill ships, including: ✓ drilling at various water depths and in locations under consideration ✓ waste management ✓ water management	2.5.2 2.9
– vertical seismic profile surveys;	2.5.2.3
– well evaluation and testing;	2.5.2.4
– equipment requirements (type, quantity); and	2.5.1
– storage and management of hazardous materials, fuels and residues.	2.9
3.2.2 Supply and Servicing	
– vessel support, including loading, refuelling and operation of marine support vessels (i.e. for transfer, re-supply and on-site safety during drilling activities); and	2.5.2.6
– helicopter support (i.e. crew transport and delivery of supplies and equipment).	2.5.2.6
3.2.3 Decommissioning, suspension or abandonment of wells	
– the preliminary outline of a well decommissioning, suspension and abandonment plan for wells at varying water depths	2.5.2.5
4. PUBLIC PARTICIPATION AND CONCERNS	
The EIS will describe the ongoing and proposed public participation activities that the proponent will undertake or that it has already conducted on the project. It will provide a description of efforts made to distribute project information and provide a description of information and materials that were distributed during the consultation process. The EIS will indicate the methods used, where the consultation was held, the persons and organizations consulted, the concerns voiced and the extent to which this information was incorporated in the design of the project as well as in the EIS. The EIS will provide a	3.0

EIS Guidelines Requirements	EIS Section(s)
summary of key issues raised related to the project and its potential effects to the environment as well as describe any outstanding issues and ways to address them.	
5. ENGAGEMENT WITH INDIGENOUS GROUPS AND CONCERNS RAISED	
For the purposes of developing the EIS, the proponent will engage with Indigenous groups that may be affected by the project, to obtain their views on:	3.3
– effects of changes to the environment on Aboriginal peoples (health and socio-economic conditions; physical and cultural heritage, including any structure, site or thing that is of historical, archaeological, paleontological or architectural significance; and current use of lands and resources for traditional purposes) pursuant to paragraph 5(1)(c) of CEAA 2012; and	3.3
– potential adverse impacts of the project on potential or established section 35 rights, including title and related interests, in respect of the Crown's duty to consult, and where appropriate, accommodate Aboriginal peoples.	3.3
With respect to the effects of changes to the environment on Aboriginal peoples as per paragraph 5(1)(c) of CEAA 2012, the assessment requirements are outlined in sections 6.1.8 and 6.3.7 below. With respect to potential adverse impacts of the project on potential or established section 35 rights, including title and related interests, the EIS will document for the groups identified in Section 5.1 below (or in subsequent correspondence from the Agency):	
– potential or established section 35 rights including title and related interests, when this information is directly provided by a group to the proponent, the Agency or is available through public records, including: ✓ geographical extent, nature, frequency and timing of the practice or exercise of the right; and, ✓ maps and data sets (e.g. fish catch numbers);	7.4 12.0
– potential adverse impacts of each of the project components and physical activities, in all phases, on potential or established section 35 rights, including title and related interests. This assessment is to be based on a comparison of the exercise of the identified rights, title and related interests between the predicted future conditions with the project and the predicted future conditions without the project. Include the perspectives of potentially impacted groups where these were provided to the proponent by the groups;	7.4 12.0
– measures identified to accommodate potential adverse impacts of the project on the potential or established section 35 rights, including title and related interests. These measures will be written as specific commitments that clearly describe how the proponent intends to implement them, and may go beyond mitigation measures that are developed to address potential adverse environmental effects;	7.4 12.0
– potential adverse impacts on potential or established section 35 rights, including title and related interests that have not been fully mitigated or accommodated as part of the EA and associated engagement with Indigenous groups. The proponent will also take into account the potential adverse impacts that may result from the residual and cumulative environmental effects. Include the perspectives of potentially affected groups where these were provided to the proponent by the groups.	7.4 12.0 15.6

EIS Guidelines Requirements	EIS Section(s)
The information sources, methodology and findings of the assessment of paragraph 5(1)(c) effects under CEAA 2012 may be used to inform the assessment of potential adverse impacts of the project on potential or established section 35 rights, including title and related interests. However, there may be distinctions between the adverse impacts on potential or established section 35 rights, including title and related interests and paragraph 5(1)(c) effects under CEAA 2012. The proponent will carefully consider the potential distinction between these two aspects and, where there are differences, will include the relevant information in its assessment.	12.0
In terms of gathering views from potentially affected groups with respect to both environmental effects of the project and the potential adverse impacts of the project on potential or established section 35 rights, including title and related interests, the EIS will document:	
– VCs suggested by groups for inclusion in the EIS, whether they were included, and the rationale for any exclusions;	3.3 4.2
– specific suggestions raised by each group for mitigating the effects of changes to the environment on Aboriginal peoples or accommodating potential adverse impacts of the project on potential or established section 35 rights, including title and related interests;	3.3 4.3.3
– views expressed by each group on the effectiveness of the mitigation or accommodation measures;	3.3 4.3.3
– from the proponent's perspective, any potential cultural, social and/or economic impacts or benefits to each group identified that may arise as a result of the project. Include the perspectives of potentially affected groups where these were provided to the proponent by the groups;	3.3 12.0
– any other comments, specific issues and concerns raised by potentially affected groups and how they were responded to or addressed;	3.3
– changes made to the project design and implementation directly as a result of discussions with potentially affected groups;	2.8
– where and how Aboriginal traditional knowledge was incorporated into the environmental effects assessment (including methodology, baseline conditions and effects analysis for all VCs) and the consideration of potential adverse impacts on potential or established section 35 rights, including title and related interests, and related mitigation measures; and	3.3.2 12.0
– any additional issues and concerns raised by potentially affected groups in relation to the environmental effects assessment and the potential adverse impacts of the project on potential or established section 35 rights, including title and related interests.	3.3
The Agency recommends the proponent create a tracking table of key issues raised by each group, including the concerns raised related to the project, proposed mitigation measures, and where appropriate, a reference to the proponent's analysis in the EIS. Information provided related to potential adverse impacts on potential or established section 35 rights will be considered by the Crown in meeting its common law duty to consult obligations as set out in the Updated Guidelines for Federal Officials to Fulfill the Duty to Consult (2011).	3.3

EIS Guidelines Requirements	EIS Section(s)
5.1 Indigenous groups and engagement activities	
With respect to engagement activities, the EIS will document:	
– the engagement activities undertaken with each group prior to the submission of the EIS, including the date and means of engagement (e.g. meeting, mail, telephone);	3.3
– any future planned engagement activities; and	3.3.8
– how engagement activities by the proponent allowed groups to understand the project and evaluate its effects on their communities, activities, potential or established section 35 rights, including title and related interests.	3.3 12.2
In preparing the EIS, the proponent will ensure that groups have access to timely and relevant information on the project and how the project may adversely impact them. The proponent will structure its engagement activities to provide adequate time for groups to review and comment on the relevant information. Engagement activities are to be appropriate to the groups' needs, arranged through discussions with the groups and in keeping with established consultation protocols, where available. The EIS will describe all efforts, successful or not, taken to solicit the information required from groups to support the preparation of the EIS.	3.3
The proponent will ensure that views of groups are recorded and that groups are provided with opportunities to validate the interpretation of their views. The proponent will keep detailed tracking records of its engagement activities, recording all interactions with groups, the issues raised by each group and how the proponent addressed the concerns raised. The proponent will share these records with the Agency.	3.3 Incl. 3.3.8
For the groups listed below, the proponent will ensure they are notified about key steps in the EIS development process and of opportunities to provide comments on key EA documents and/or information to be provided regarding their community. The proponent will ensure these groups are reflected in the baseline information and assessment of potential environmental effects as described under paragraph 5(1)(c) of CEAA 2012 and/or impacts to potential or established section 35 rights, including title and related interest in the EIS. These groups include: Newfoundland and Labrador – the Labrador Inuit (Nunatsiavut Government) – the Labrador Innu (Innu Nation) – the NunatuKavut Community Council Nova Scotia – 11 Mi'kmaq First Nation groups represented by Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO): o Acadia First Nation o Annapolis Valley First Nation o Bear River First Nation o Eskasoni First Nation o Glooscap First Nation o Membertou First Nation o Paqtnkek Mi'kmaw Nation o Pictou Landing First Nation o Potlotek First Nation o Wagmatcook First Nation	3.3 12.0

EIS Guidelines Requirements	EIS Section(s)
○ Waycobah First Nation – Millbrook First Nation – Sipekne'katik First Nation New Brunswick – eight Mi'gmaq First Nations groups represented by Mi'gmawe'l Tplu'taqnn Inc. (MTI) ○ Fort Folly First Nation ○ Eel Ground First Nation ○ Pabineau First Nation ○ Esgenoôpetitj First Nation ○ Buctouche First Nation ○ Indian Island First Nation ○ Eel River Bar First Nation ○ Metepnagiag Mi'kmaq First Nation – Elsipogtog First Nation – six Maliseet First Nation groups represented by Maliseet Nation of New Brunswick (MNNB) ○ Kingsclear First Nation ○ Madawaska Maliseet First Nation ○ Oromocto First Nation ○ Saint Mary's First Nation ○ Tobique First Nation ○ Woodstock First Nation – Peskotomuhkati Nation at Skutik (Passamaquoddy) Prince Edward Island – Abegweit First Nation – Lennox Island First Nation Quebec – three Mi'gmaq First Nation groups represented by Mi'gmawei Mawiomi Secretariat (MMS) ○ Micmas of Gesgapegiag ○ La Nation Micmac de Gespeg ○ Listuguj Mi'gmaq Government – Les Innus de Ekuanitshit – Montagnais de Nutashkuan	
The groups referenced above may change as more is understood about the environmental effects or potential impacts on rights of the project and/or if the project or its components change during the EA. The Agency reserves the right to alter the list of groups that the proponent will engage with as additional information is gathered during the EA.	3.3.8
In addition, for the purposes of good governance, the proponent should also provide information to and discuss potential environmental effects from the Project, as described under section 5(1)(c) of CEAA 2012, with the Qalipu Mi'kmaq First Nation Band and the Miawpukek First Nation.	3.3.3.4 3.3.3.5
Upon receipt of knowledge or information of potential effects or adverse impacts to a group not listed above, the proponent shall provide that information to the Agency at the earliest opportunity.	n/a

EIS Guidelines Requirements	EIS Section(s)
6. EFFECTS ASSESSMENT	
6.1. Project setting and baseline conditions	
Based on the scope of the project described in Section 3 (Part 1), the EIS will present baseline information in sufficient detail to enable the identification of how the project could affect the VCs and an analysis of those effects. Should other VCs be identified during the conduct of the EA, the baseline condition for these components will also be described in the EIS. To determine the appropriate spatial boundaries to describe the baseline information, refer to Section 3.2.3 (Part 1) of these guidelines. As a minimum, the EIS will include a description of the following environmental components.	5.0 6.0 7.0
6.1.1. Atmospheric Environment	
The EIS will describe the atmospheric environment and climate at the project site and within areas that could be affected by routine project operations or accidents and malfunctions, such as:	5.3 5.4
– ambient air quality in the project areas and in the airshed likely to be affected by the project, including consideration of the following contaminants: total suspended particulates (TSP), fine particulates smaller than 2.5 microns ($PM_{2.5}$), respirable particulates of less than 10 microns (PM_{10}), carbon monoxide (CO), sulphur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs), hydrogen sulfide (H_2S) and any other potentially toxic air pollutants;	5.4
– identify and quantify existing greenhouse gas emissions by individual pollutant measured as kilotonnes of CO_2 equivalent per year in the project study areas;	5.4
– direct and indirect sources of air emissions;	5.4
– ambient noise and light levels;	5.4 14.0
– current provincial/territorial/federal limits for greenhouse gas emission targets; and	14.0
– information on the variation in weather conditions over the project area using historical records of relevant meteorological parameters, including the following: ✓ precipitation (rain and snow); ✓ air temperature (mean, maximum and minimum temperatures); ✓ wind speed and direction; ✓ freezing spray; ✓ lightning; and ✓ visibility.	5.3
Particular attention should also be given to the analysis of extreme meteorological events that have the potential to result in adverse effects on the project (e.g. high wind events).	5.3 17.1
Relevant marine climate data sources should be consulted, including but not limited to data from Environment and Climate Change Canada moored weather buoys and any offshore platforms operating in the Eastern Newfoundland Strategic Environmental Assessment (SEA) area. Data from the International Comprehensive Atmosphere Ocean Dataset (ICOADS), the United States of America National Oceanographic and Atmospheric Administration (NOAA) database of tropical cyclone activity in the North Atlantic, NOAA's Climate Forecast System Reanalysis (CFSR), and the Canadian Lightning Detection Network.	5.3

EIS Guidelines Requirements	EIS Section(s)
6.1.2 Marine environment	
The EIS will describe the marine environment within areas that could be affected by routine project operations or by accidents and malfunctions, including:	
– marine water quality (e.g. water temperature, turbidity, salinity and pH);	5.5.4
– marine geology and geomorphology (i.e. bottom sediments, including quality, thickness, grain size, and mobility);	5.1
– physical oceanography including surface and subsurface current patterns, current velocities, waves, storm surges, long shore drift processes, tidal patterns, and tide gauges levels for the site, in proximity to the site, and along the marine transportation routes with consideration of predicted climate change effects;	5.5 17.1
– available bathymetric information (e.g. maximum and mean water depths) for the site and along marine transportation routes if applicable;	5.2
– ice climate in the regional study area, including ice formation and thickness, breakup and movement;	5.6
– ice conditions along the marine transportation routes with consideration of predicted climate change and its possible effect on the timing of ice formation in the future;	5.6
– fast-ice characteristics, including its surface area and seasonal stability along the marine transportation routes;	5.6
– marine plants, including all benthic and detached algae, marine flowering plants, brown algae, red algae, green algae and phytoplankton;	6.1.5
– acoustic environment (ambient noise levels from natural sources, shipping, seismic surveys, and other sources), including information on geographic extent and temporal variations and how the acoustic environment may be affected by the project.	5.5.7 Appendix E
When describing the baseline marine environment, relevant data sources should be consulted. In addition to data sources discussed under Atmospheric Environment and Climate (some of which contain marine data), the proponent should consult MSC50 Wind and Wave Hindcast Data, and long term gridded hourly wind and wave measurements for the North Atlantic.	5.3 5.5
6.1.3 Fish and fish habitat	
The EIS will describe fish and fish habitat within areas that could be affected by routine project operations or by accidents and malfunctions, including:	6.1
– a characterization of fish populations on the basis of species and life stage, including information on the surveys carried out (e.g. location of sampling stations, catch methods, date of catches, species, catch per-unit effort) and the source of data available (e.g. government and historical databases, commercial fishing data);	6.1
– a description of primary and secondary productivity in affected water bodies with a characterisation of seasonal variability;	6.1

EIS Guidelines Requirements	EIS Section(s)
– a list of any federally or provincially listed fish or invertebrate species at risk that are known to be present; and	6.1.8
– benthic flora and fauna and their associated habitat, including sensitive features such as corals and sponges (Note: a benthic habitat survey (ROV / camera), including transects of seafloor in the area of the well locations, may be required).	6.1.2 6.1.6
Emphasis will be placed on the waters likely to be affected by the project and their physical characteristics, water and sediment quality. Hence, for all areas in which effects are anticipated, the EIS will describe the biophysical water and sediment characteristics, including:	
– a description of the physical and biological characteristics of the fish and fish habitat likely to be directly or indirectly affected by the project;	6.1
– maps, at a suitable scale, indicating the surface area of potential or confirmed fish habitats and a description of these habitats as determined by water depths, type of substrate (sediments), aquatic vegetation, and potential use (i.e. spawning, rearing, nursery, feeding, overwintering, migration routes, etc.). Where appropriate, this information should be linked to water depths (bathymetry) to identify the extent of a water body's littoral / photic zone;	6.1
– quality, thickness, grain size and mobility of bottom sediments; and	5.1
– a discussion of sea bottom stability at the project site.	5.1
Any sampling survey methods used by the proponent will be described in order to allow experts to ensure the quality of the information provided. If previous studies on the habitat in the study area were conducted, they are to be submitted with the EIS.	6.1.2
6.1.4 Migratory birds and their habitat	
The EIS will describe migratory and non-migratory marine birds and their habitat at the project site and within areas that could be affected by routine project operations or accidents and malfunctions.	6.2
Migratory birds are protected under the Migratory Birds Convention Act (MBCA) and associated regulations. Preliminary data from existing sources will be gathered, including information such as:	6.2
– birds and their habitats that are found or are likely to be found in the study area. This description may be based on existing sources, but supporting evidence is required to demonstrate that the data used are representative of the avifauna and habitats found in the study area. The existing data must be supplemented by surveys, if required;	6.2 Incl 6.2.1
– abundance, distribution, and life stages of migratory and non-migratory birds likely to be affected in the project area based on existing information, or surveys, as appropriate, to provide current field data;	6.2
– year-round migratory bird use of the area (e.g. winter, spring migration, breeding season, fall migration), based on preliminary data from existing sources and surveys to provide current field data if appropriate; and	6.2 Incl 6.2.1
– areas of concentration of migratory birds, such as for breeding, feeding or resting.	6.2.7

EIS Guidelines Requirements	EIS Section(s)
Other relevant datasets should be consulted, such as those available from the Canadian Wildlife Service (e.g. Eastern Canadian Seabirds at Sea (ECSAS), Programme intégré de recherches sur les oiseaux pélagiques (PIROP)), the Atlantic Canada Conservation Data Centre (ACCDC), recovery strategies, management plans, Newfoundland and Labrador Department of Environment and Climate Change Wildlife Division, previous petroleum operations in the area and university or other research programs, if available.	6.2.1
6.1.5 Species at risk	
The EIS will describe federal species at risk and their habitat at the project site and within areas that could be affected by routine project operations or accidents and malfunctions, such as:	
– a list of all potential or known federally listed species at risk that may be affected by the project, using existing data and literature as well as surveys to provide current field data;	6.1.8 6.2.6 6.3.5
– a list of all federal species designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for listing on Schedule 1 of the Species at Risk Act. This will include those species in the risk categories of extirpated, endangered, threatened and of special concern;	6.1.8 6.2.6 6.3.5
– any published studies that describe the regional importance, abundance and distribution of species at risk including management plans, recovery strategies and/or action plans. The existing data must be supplemented by surveys, if required; and	6.1.8 6.2.6 6.3.5
– residences, seasonal movements, movement corridors, habitat requirements, key habitat areas, identified and proposed critical habitat and/or recovery habitat (where applicable) and general life history of species at risk that may occur in the project area, or be affected by the project.	6.1.8 6.2.6 6.3.5
The following information sources on species at risk and species of conservation concern should be among those consulted: ✓ Species at Risk Act Registry (www.sararegistry.gc.ca); ✓ COSEWIC; ✓ Relevant government agencies; ✓ Local naturalist and interest groups; and ✓ Indigenous groups and First Nations.	6.1.8 6.2.6 6.3.5
6.1.6. Marine mammals	
The EIS will describe marine mammals and their habitat at the project site and within areas that could be affected by routine project operations or accidents and malfunctions, such as:	6.3
– marine mammal species that may be present, the times of year they are present, the ranges of the species and their migration patterns, and	6.3
– important areas in the vicinity of the drilling sites or supply routes (e.g. for mating, breeding, feeding and nursing of young) or that could be impacted by the project (e.g. acoustics, spills, etc.).	6.3.6
6.1.7 Marine turtles	
The EIS will describe marine turtles and their habitat at the project site and within areas	6.3

EIS Guidelines Requirements	EIS Section(s)
that could be affected by routine project operations or accidents and malfunctions, such as:	
– marine turtle species that may be present, the times of year they are present, the ranges of the species and their migration patterns; and	6.3
– important areas in the vicinity of the drilling sites or supply routes (e.g. for mating, breeding, and feeding) or that could be impacted by the project (e.g. routine discharges, spills, etc.).	6.3.6
6.1.8 Indigenous Peoples	
With respect to potential effects on Indigenous peoples and the related VCs, baseline information will be provided for each group identified in Section 5 (Part 2) of these guidelines (and any groups identified after these guidelines are finalized). Baseline information will describe and characterize the elements in paragraph 5(1)(c) of CEAA 2012 based on the spatial and temporal scope selected for the EA according to the factors outlined in Part 1, Section 3.2.3 of this document. Baseline information will also characterize the regional context of each of the elements of paragraph 5(1)(c) of CEAA 2012 to support the assessment of project related effects and cumulative effects. Baseline information will be sufficient to provide a comprehensive understanding of the current state of each VC.	7.4
Baseline information for current use of lands and resources for traditional purposes will focus on the traditional activity (e.g. fishing) and include a characterization of all attributes of the activity that can be affected by environmental change. This includes not only identifying species of importance, but also assessing the quality and quantity of preferred traditional resources and locations, timing (e.g. seasonality, access restrictions, distance from community), ambient/sensory environment (e.g. noise, air quality, visual landscape, presence of others) and cultural environment (e.g. historical/generational connections, preferred areas). As applicable, specific aspects that will be considered include, but are not limited to:	7.4
– current use of lands and resources for traditional purposes, including: ✓ location of traditional territory (including maps where available); ✓ commercial and traditional fishing activity within the project's potential zone of influence, including licences and maps; ✓ fish, wildlife, birds, plants or other natural resources of importance for traditional use; ✓ places where fish, wildlife, birds, plants or other natural resources are harvested, including places that are preferred; ✓ access and travel routes for conducting traditional practices; ✓ frequency, duration or timing of traditional practices; and ✓ cultural values associated with the area affected by the project and the traditional uses identified.	7.4
– any Project components and a description of any activities (e.g. exclusion zones) that may affect commercial fisheries or other uses;	2.5.2 13.3
– human health primarily with respect to potential contamination of food sources;	7.4
– location of reserves and communities; and	7.4

EIS Guidelines Requirements	EIS Section(s)
– physical and cultural heritage (including any site, structure or thing of archaeological, paleontological, historical or architectural significance).	7.4
Any other baseline information that supports the analysis of predicted effects on Indigenous peoples will be included as necessary. The EIS will also indicate how input from groups, including Aboriginal traditional knowledge, was used in establishing the baseline conditions related to health and socio-economics, physical and cultural heritage and current use of lands and resources for traditional purposes.	3.3 7.4
6.1.9 Other changes to the environment arising as a result of a federal decision or due to changes on federal lands, in another province or outside Canada	
Should there be the potential for a change to the environment arising as a result of a federal decision(s), or on federal lands, lands in another province or lands outside Canada, the EIS will include baseline information on the environmental component likely to be affected (if this information is not already covered in other subsections of these guidelines).	5.0 6.0 7.0 18.5
6.1.9.1 Special areas	
The EIS will describe special areas (e.g. species at risk critical habitat that has been designated and that has been proposed or that may be under consideration, Important Bird Areas, Migratory Bird Sanctuaries, ecological reserves, etc.) at the project site and within areas that could be affected by routine project operations or accidents and malfunctions, such as: – Ecologically and Biologically Significant Areas (e.g. The Southeast Shoal and Tail of the Banks, The Northeast Shelf and Slope, Lily Canyon-Carson Canyon and The Virgin Rocks) – Fishery Closure Areas (e.g. Northwest Atlantic Fisheries Organization Coral Closures, Orphan Knoll Seamount) – Preliminary Representative Marine Areas (South Grand Bank Area)	6.4
The EIS will describe the distances between the edge of the project area (i.e. drill sites and marine transportation routes) and special areas. It shall state the rationale for designating specific areas as “special” (i.e. the environmental features that define the special area).	6.4 11.3
6.1.9.2 Human environment	
With respect to potential effects on the human environment, non-Indigenous people and the related VCs, baseline information will describe and characterize the following that could be affected by routine project operations or accidents and malfunctions. At a minimum, this should include:	7.0
– any federal lands, lands located outside the province or Canada that may be affected by the project operations or by accidents and malfunctions;	1.3 7.3.5
– the current and historical use of waters that may be affected by routine project operations or by accidents and malfunctions, including: ✓ current commercial and recreational fishing activity, including licence holders and species fished; ✓ other ocean uses (e.g. shipping, research, oil and gas, military, ocean infrastructure [e.g. subsea cable]);	4.2 7.2 7.3
– the location of and proximity of any permanent, seasonal or temporary residences or camps that could be affected by routine project operations or accidents and malfunctions;	4.2 7.1

EIS Guidelines Requirements	EIS Section(s)
– health and socio-economic conditions that could be affected by routine project operations or accidents and malfunctions, including the functioning and health of the socio-economic environment, encompassing a broad range of matters that affect communities in the study area in a way that recognizes interrelationships, system functions and vulnerabilities;	4.2 7.1
– physical and cultural heritage, including structures, sites or things of historical, archaeological, paleontological or architectural significance that could be affected by routine project operations or accidents and malfunctions;	4.2 7.1
– the rural and urban settings that could be affected by routine project activities or accidents and malfunctions; and	4.2 7.1
– any project components and activities (e.g. exclusion zones) that may affect commercial or recreational fisheries or other uses.	2.5 13.3
The EIS should also discuss the potential to encounter unexploded ordnance (UXOs), based on consultation with the Department of National Defence.	7.3.4 13.2
6.2 Predicted changes to the physical environment	
The EA will include a consideration of the predicted changes to the environment as a result of the project being carried out or as a result of any powers, duties or functions that are to be exercised by the federal government in relation to the project. These predicted changes to the environment are to be considered in relation to each phase of the project (e.g. drilling, testing, decommissioning, suspension, abandonment) and are to be described in terms of the magnitude, geographic extent, timing, duration, frequency, ecological and social context, and whether the environmental changes are reversible or irreversible.	8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 18.0
The EIS will include stand-alone sections that summarise those changes that may be caused by the project on the components of the environment listed in paragraph 5(1)(a) of CEAA 2012, namely fish and fish habitat, aquatic species and migratory birds.	8.0 9.0 10.0 18.5
The EIS will include a stand-alone section that summarises any change the project may cause to the environment that may occur on federal lands or lands outside the province in which the project is to be located (including outside of Canada).	18.5
In situations where the project requires one or more federal decisions identified in section 5(2), the EIS will also include a stand-alone section that describes any change that may be caused by the project on the environment that is directly linked or necessarily incidental to these decisions (e.g. changes to commercial fishing).	18.5
6.3 Predicted effects on valued components	
Based on the predicted changes to the environment identified in Section 6.2 above, the proponent is to assess the environmental effects of the project on the following VCs. All interconnections between VCs and between changes to multiple VCs will be described:	4.2 4.3
6.3.1 Fish and fish habitat	
– the identification of any potential adverse effects to fish and fish habitat as defined in subsection 2(1) of the Fisheries Act, including the calculations of any	8.0

EIS Guidelines Requirements	EIS Section(s)
potential habitat loss (temporary or permanent) in terms of surface areas (e.g. spawning grounds, juvenile, rearing and feeding areas), and in relation to availability and significance. The assessment will include a consideration of:	
✓ effects on water quality including changes to chemical composition, temperature, oceanographic conditions, etc.;	8.2 8.3 8.4 8.5
✓ the geomorphological changes and their effects on hydrodynamic conditions and fish habitats (e.g. modification of benthic habitat including corals and sensitive habitat, area affected by drilling waste, disturbance to water column);	
✓ the modifications of hydrological and hydrometric conditions on fish habitat and on the fish species' life cycle activities (e.g. reproduction, juvenile, rearing, and feeding, movements);	
✓ any potential imbalances in the food web in relation to baseline conditions;	
✓ underwater noise and vibration emissions from project activities (i.e. drilling, vertical seismic profiling, offshore supply vessel operation, well abandonment) and how it may affect fish health and behaviour;	
✓ effects on the primary and secondary productivity of water bodies and how project-related effects may affect fish food sources;	
– the effects of changes to the aquatic environment on fish and their habitat, including:	8.0
✓ the anticipated changes in the composition and characteristics of the populations of various fish species, including shellfish and forage fish including mortality of fish, eggs and larvae; environment and species (e.g. corals, plants);	8.2 8.3 8.4 8.5
✓ any modifications in migration or local movements during and after project activities (e.g. vertical seismic profiling, drilling);	
✓ any modifications and use of habitats by federally or provincially listed fish species at risk;	8.4
– a discussion of the effects of drilling waste disposal on fish health, marine benthos (fish habitat) and other components of the aquatic environment, recognizing that the disposal of these wastes is expected to be a primary cause of effect on benthos;	8.3.4
– a discussion of the length of time it would take for the benthic environment to return to baseline conditions in water depths within which the Project would occur;	8.3.4 8.5.1
– a discussion of how project timing correlates to key fisheries windows and any potential effects resulting from overlapping periods; and	6.1 8.0
– a discussion of how data examining the deposition of drilling-related wastes (e.g. fluid, mud residues, cuttings) and acoustic monitoring data would be collected during and after drilling operations and how this would be used to verify effects predictions.	8.6

EIS Guidelines Requirements	EIS Section(s)
6.3.2 Marine plants	
– effects on marine plants, including all benthic and detached algae, marine flowering plants, brown algae, red algae, green algae and phytoplankton.	8.0
6.3.3 Marine mammals	
– effects on marine mammals, including but not limited to:	10.0
✓ mortality and other effects from vessel collisions or disturbance;	10.2 10.3 10.4 10.5
✓ direct and indirect effects caused by increased disturbance (e.g. noise, light, vibrations) including mortality, physical injury and behavioural changes (e.g. habitat avoidance, disruption to feeding behaviour, deviation in migration routes, communication masking, discomfort and behavioural disturbance);	
✓ exposure to spilled contaminants (e.g. fuel, oils) and operational discharges (e.g. deck drainage, gray water, black water); and	
✓ change in marine habitat quality from drill muds and cuttings and sedimentation.	
6.3.4 Marine turtles	
– effects on marine turtles, including but not limited to:	10.0
✓ mortality and other effects from vessel collisions or disturbance;	10.2 10.3 10.4 10.5
✓ direct and indirect effects caused by increased disturbance (e.g. noise, light, vibrations) including mortality, physical injury and behavioural changes (e.g. habitat avoidance, disruption to feeding behaviour, deviation in migration routes, communication masking, discomfort and behavioural disturbance);	
✓ exposure to spilled contaminants (e.g. fuel, oils) and operational discharges (e.g. deck drainage, gray water, black water); and	
✓ change in marine habitat quality from drill muds and cuttings and sedimentation.	
6.3.5 Migratory birds	
– direct and indirect adverse effects on migratory birds, including population level effects that could be caused by all project activities, including but not limited to:	9.0
✓ noise disturbance from seismic equipment including both direct effects (physiological), or indirect effects (foraging behaviour of prey species)	9.3.6
✓ physical displacement as a result of vessel presence (e.g. disruption of foraging activities);	9.3.3 9.3.8
✓ night-time illumination levels from lights and flares during different weather conditions and seasons and during different project activities (e.g. drilling, well testing) and associated nocturnal disturbance (e.g. increased opportunities for predators, attraction to the drilling unit and vessels and subsequent collision or exposure to vessel-based threats, incineration in flares, disruption of normal activities);	9.3
✓ exposure to spilled contaminants (e.g. fuel, oils) and operational discharges (e.g. deck drainage, gray water, black water);	9.3

EIS Guidelines Requirements	EIS Section(s)
✓ attraction of, and increase in, predator species as a result of waste disposal practices (i.e. sanitary and food waste) and the presence of incapacitated/dead prey near the Mobile Offshore Drilling Unit or support vessels;	9.3
✓ physical harm or mortality from flaring on the drilling unit or other vessel based threats;	9.3
✓ collision risk with the drilling unit and other project infrastructure;	9.3
✓ the effects of oil spills in the nearshore or that reach land on landbird species;	16.6.3 Appendix G
✓ change in marine habitat quality from drill muds and cuttings and sedimentation; and	9.3.4
✓ indirect effects caused by increased disturbance (e.g. noise, light, presence of workers), relative abundance movements and changes in migratory bird habitat.	9.3
6.3.6 Species at risk	
– the potential effects of the project on federally listed species at risk and those species listed by the Committee on the Status of Endangered Wildlife in Canada classified as extirpated, endangered, threatened or of special concern (flora and fauna) and their critical habitat, including:	
✓ alteration of habitat (including critical habitat) features;	8.4 9.4 10.4
✓ direct and indirect effects from noise, vibrations and increased exposure to contaminants of concern;	
✓ a discussion of migration patterns of federal species at risk and related effects (e.g. displacement, increased risk of collision); and	
✓ direct and indirect effects on the survival or recovery of federally listed species (list species).	
6.3.7 Indigenous peoples	
With respect to Indigenous peoples, a description and analysis of how changes to the environment caused by the project will affect the following activities as exercised **each group** identified in Section 5 (Part 2) of these guidelines (and any groups identified after these guidelines are finalized), as applicable to the proposed project:	12.0
current use of lands and resources for traditional purposes. This assessment will characterize the effects on the use or activity (e.g. fishing) as a result of the underlying changes to the environment (i.e. how will the activity change if the project proceeds). The underlying changes to the environment will also be described, including, but not limited to:	12.3.3.2
✓ any changes to resources (fish, birds, or other natural resources) used for traditional purposes (e.g. fishing, use of sacred sites);	
✓ effects on food, social, ceremonial, and commercial fishing;	
✓ a discussion of how drilling activities correlates to key fisheries windows, and any potential impacts resulting from overlapping periods;	

EIS Guidelines Requirements	EIS Section(s)
✓ changes related to species important to Indigenous people's current use of resources, including changes to key habitat;	
✓ any changes or alterations to access into the areas used for traditional purposes and commercial fishing, including implementation of exclusion zones;	
✓ any changes to the environment that affect cultural value or importance associated with traditional uses or areas affected by the project (e.g. values or attributes of the area that make it important as a place for inter-generational teaching of language or traditional practices, communal gatherings, integrity of preferred traditional practice areas);	
✓ how timing of project activities (e.g. drilling, flaring) have the potential to interact with the timing of traditional practices, and any potential effects resulting from overlapping periods;	
✓ consideration of the regional context for traditional use and the value of the project area in that regional context, including alienation of lands from traditional use;	
✓ any changes to environmental quality (e.g. air, water), the sensory environment (e.g. noise, light, visual landscape), or perceived disturbance of the environment (e.g. fear of contamination of water or country foods) that could detract from use of the area or lead to avoidance of the area;	
✓ an assessment of the potential to return affected areas to pre-project conditions to support traditional practices;	
– human health, focusing on effects on health outcomes or risks in consideration of, but not limited to, potential changes in water quality (recreational and cultural uses), availability of country foods (e.g. marine species), and noise exposure. When risks to human health due to changes in one or more of these components are predicted, a complete Human Health Risk Assessment (HHRA) examining all exposure pathways for pollutants of concern may be necessary to adequately characterize potential risks to human health. Where adverse health effects are predicted, any incidental effects such as effects on current use of lands and resources for traditional purposes will also be assessed. The proponent must provide a justification if it determines that an assessment of the potential for contamination of country foods is not required or if some contaminants are excluded from the assessment;	4.2 12.3.3.1
– socio-economic conditions, including, but not limited to:	4.2 12.3.3.1 13.0
✓ the use of navigable waters	
✓ commercial fishing (e.g. catch rates, exclusion zones, gear damage or loss, well abandonment, marketability of seafood products) and food security	
✓ commercial outfitters	
✓ recreational use	
– physical and cultural heritage, and structures, sites or things of historical, archaeological, paleontological or architectural significance to groups, including, but not limited to:	12.3.3.3
✓ the loss or destruction of physical and cultural heritage	
✓ changes to access to physical and cultural heritage	

EIS Guidelines Requirements	EIS Section(s)
✓ changes to the cultural value or importance associated with physical and cultural heritage	
– other effects of changes to the environment on groups should be reflected as necessary.	12.1
6.3.8 Other valued components that may be affected as a result of a federal decision or due to effects on federal lands, another province or outside Canada	
If there is the potential for a change to the environment arising as a result of a federal decision(s), for example an authorization under section 138(1) of the Canada-Newfoundland and Labrador Atlantic Accord Implementation Act or section 35 of the Fisheries Act, the EIS should include a description of the specific project components for which a federal authorisation/decision is required, and an assessment of any other VCs (not already covered in other subsections of these guidelines) that may be affected by the changes to the environment caused by these specific project components. If there is the potential for the project to result in environmental changes on federal lands (or waters), another province, or another country, then VCs of importance not already identified should be included. For example, if the project will result in the generation of greenhouse gas emissions, the EIS should include a description of the project's greenhouse gas emissions in a regional, provincial, national or international context if applicable. Suggested VCs are noted below for this project.	1.5 8.0-16.0 18.5
6.3.8.1 Air quality and greenhouse gas emissions	
– comparison of anticipated air quality concentration against the Canadian Ambient Air Quality Standards (CAAQS) for fine particulate matter or other relevant federal and/or provincial criteria for other contaminants of potential concern;	14.3 14.4.1
– description of all methods and practices (e.g. control equipment) that will be implemented to minimize and control atmospheric emissions throughout the project life cycle. If the best available technologies are not included in the project design, the proponent will need to provide a rationale for the technologies selected;	2.9.1 14.3
– an estimate of the direct greenhouse gas emissions associated with all phases of the project (i.e. including drilling, well testing and marine and helicopter transportation) as well as any mitigation measures proposed to minimize greenhouse gas emissions. This information is to be presented by individual pollutant and should also be summarized in CO_2 equivalent per year. The proponent is responsible for the following:	14.3 14.4
✓ provide an estimate of the contribution of the project emissions at the local, provincial and federal scale, and indicate the category into which the project falls in terms of the relative magnitude of its contribution to greenhouse gas emissions (project with low, medium or high emission rates);	14.3 14.4
✓ justify all estimated emissions and emission factors used;	14.3 14.4
✓ provide the estimation or derivation method, and disclose and describe all assumptions and emission intensity factors used;	14.3 14.4

EIS Guidelines Requirements	EIS Section(s)
✓ compare and assess the level of estimated emissions to the regional, provincial and federal emission targets;	14.3 14.4
✓ provide information related to the project's electrical demand and sources of electrical power for equipment, i.e. the project's main source and any other additional sources (generators, etc.), as appropriate;	14.3 14.4
– changes in ambient noise levels; and	14.1
– changes in night-time light levels.	14.1
6.3.8.2 Commercial fisheries	
– effects of changes to the environment on commercial fishing activities (e.g. effects on fished species affecting fisheries success, displacement from fishing areas (e.g. exclusion zones), gear loss or damage);	13.2 13.3 13.4
– a discussion of how drilling activities correlates to key commercial fisheries windows, and any potential impacts resulting from overlapping periods;	13.2 13.3 13.4
– effects from subsea infrastructure that could be left in place (e.g. wellheads) following abandonment; and	13.3.7
– changes to habitat of commercial fish species (e.g. noise, water and sediment quality).	8.0 13.2
6.3.8.3 Special areas	
– effects on special areas, including, but not limited to:	11.0
✓ use of dispersants;	16.6
✓ change to habitat quality (e.g. noise, light, water, sediment quality); and	11.2 11.3
✓ change to the environmental features that define the special area (e.g. physical features, species assemblages, species abundance).	11.2 11.3 11.4
6.3.8.4 Human environment	
– effects of changes to the environment on health and socio-economic conditions, physical and cultural heritage and any structure, site or thing that is of historical, archaeological, paleontological, or architectural value, including, but not limited to the following, as applicable:	4.2 13.2 13.3 13.4
✓ recreational activities;	
✓ other ocean uses;	
✓ socio-economic conditions;	
✓ human health;	
✓ physical and cultural heritage (e.g. shipwrecks);	
✓ rural and urban settings that could be affected by routine activities and/or accidents and malfunctions.	

EIS Guidelines Requirements	EIS Section(s)
6.4 Mitigation measures	
Every EA conducted under CEAA 2012 will consider measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project. Under CEAA 2012, mitigation measures includes measures to eliminate, reduce or control the adverse environmental effects of a designated project, as well as restitution for damage to the environment through replacement, restoration, compensation or other means. Measures will be specific, achievable, measurable and verifiable, and described in a manner that avoids ambiguity in intent, interpretation and implementation. Mitigation measures may be considered for inclusion as conditions in the EA decision statement and/or in other compliance and enforcement mechanisms provided by other authorities' permitting or licensing processes.	4.3.3
As a first step, the proponent is encouraged to use an approach based on the avoidance and reduction of the effects at the source. Such an approach may include the modification of the design of the project or relocation of project components.	4.3.3
The EIS will describe the standard mitigation practices, policies and commitments that constitute technically and economically feasible mitigation measures and that will be applied as part of standard practice regardless of location. The EIS will then describe the project's environmental protection plan and its environmental management system, through which the proponent will deliver this plan. The plan will provide an overall perspective on how potentially adverse effects would be minimized and managed over time. The EIS will further discuss the mechanisms the proponent would use to require its contractors and sub-contractors to comply with these commitments and policies and with auditing and enforcement programs.	4.3.3 8.3.2 9.3.2 10.3.2 11.3 12.3 13.3.2 14.3.2 17.3 18.2
The EIS will then describe mitigation measures that are specific to each environmental effect identified. Mitigation measures will be written as specific commitments that clearly describe how the proponent intends to implement them and the environmental outcome the mitigation measure is designed to address. The EIS will describe mitigation measures in relation to species and/or critical habitat listed under the Species at Risk Act. These measures will be consistent with any applicable recovery strategy and action plans.	4.3.3 8.3.2 9.3.2 10.3.2 11.3 12.3 13.3.2 14.3.2 17.3 18.2
The EIS will specify the actions, works, minimal disturbance footprint techniques, best available technology, corrective measures or additions planned during the project's various phases to eliminate or reduce the significance of adverse effects. The EIS will also present an assessment of the effectiveness of the proposed technically and economically feasible mitigation measures. The reasons for determining if the mitigation measure reduces the significance of an adverse effect will be made explicit. The proponent is also encouraged to identify mitigation measures for effects that are adverse although not significant.	4.3.3 8.3.2 9.3.2 10.3.2 11.3 12.3 13.3.2 14.3.2 17.3 18.2
The EIS will indicate what other technically and economically feasible mitigation measures were considered, and explain why they were rejected. Trade-offs between cost savings and effectiveness of the various forms of mitigation measures will be justified. The EIS will	4.3.3

EIS Guidelines Requirements	EIS Section(s)
identify who is responsible for the implementation of these measures and the system of accountability.	
Where mitigation measures are proposed to be implemented for which there is little experience or for which there is some question as to their effectiveness, the potential risks and effects to the environment should those measures not be effective will be clearly and concisely described. In addition, the EIS will identify the extent to which technological innovations will help mitigate environmental effects. Where possible, it will provide detailed information on the nature of these measures, their implementation, management and the requirements of the follow-up program.	4.3.3
Adaptive management is not considered as a mitigation measure, but if the follow-up program (refer to Section 8 below) indicates that corrective action is required, the proposed approach for managing the action should be identified.	4.3.4 18.4.3
6.5 Significance of residual effects	
After having established the technically and economically feasible mitigation measures, the EIS will present any residual environmental effects of the project on the VCs identified in Section 6.3 above. The residual effects, even if very small or deemed insignificant, will be described.	4.3.3 8.5 9.5 10.5 11.4 12.4 13.4 14.4
The EIS will then provide a detailed analysis of the significance of the residual environmental effects that are considered adverse following the implementation of mitigation measures, using guidance described in Section 4 of the Agency's Operational Policy Statement, Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012.	
The EIS will identify the criteria used to assign significance ratings to any predicted adverse effects. It will contain clear and sufficient information to enable the Agency, technical and regulatory agencies, Indigenous groups, and the public to review the proponent's analysis of the significance of effects. The EIS will document the terms used to describe the level of significance.	4.3.3 8.1.3 9.1.3 10.1.3 11.1.3 12.1.3 13.1.3 14.1.3
The following criteria should be used in determining the significance of residual effects: ✓ magnitude ✓ geographic extent ✓ timing ✓ duration ✓ frequency ✓ reversibility ✓ ecological and social context ✓ existence of environmental standards, guidelines or objectives for assessing the effect	4.3.3 8.1.3 9.1.3 10.1.3 11.1.3 12.1.3 13.1.3 14.1.3
In assessing significance against these criteria the proponent will, where possible, use relevant existing regulatory documents, environmental standards, guidelines, or objectives such as prescribed maximum levels of emissions or discharges of specific hazardous	4.3.3 8.1.3 9.1.3

EIS Guidelines Requirements	EIS Section(s)
agents into the environment. The EIS will contain a section which explains the assumptions, definitions and limits to the criteria mentioned above in order to maintain consistency between the effects on each VC.	10.1.3 11.1.3 12.1.3 13.1.3 14.1.3
Where significant adverse effects are identified, the EIS will set out the probability (likelihood) that they will occur, and describe the degree of scientific uncertainty related to the data and methods used within the framework of this environmental analysis.	4.3.3 16.6.3 18.3
6.6 Other effects to consider	
6.6.1 Effects of potential accidents or malfunctions	
The failure of certain works caused by equipment malfunctions, human error or exceptional natural events (e.g. earthquake, hurricane, submarine landslide) could cause adverse environmental effects. The proponent will therefore conduct an analysis of the risks of accidents and malfunctions, determine their effects, and present preliminary emergency response measures.	4.5 16.0
Taking into account the lifespan of different project components, the proponent will identify the probability of potential accidents and malfunctions related to the project, including an explanation of how those events were identified, potential consequences (including the environmental effects as defined in section 5 of CEAA 2012), the plausible worst case scenarios for each accident and malfunction type and the environmental effects of these scenarios. The EIS will identify the measures to be put in place to prevent , prepare for, and respond to all such scenarios (e.g. contingency and emergency procedures). The EIS will also describe the existing mechanisms and arrangements with response organizations for emergency response within the spatial extent of the project.	16.2 16.3 16.4 Appendix F
This assessment will include an identification of the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form and characteristics of the contaminants and other materials likely to be released into the environment during the accident and malfunction events and would potentially result in an adverse environmental effect as defined in section 5 of CEAA 2012. The spatial boundaries will identify the areas that could potentially be affected by a worst-case scenario for each accident type.	16.3 16.4
The EIS will describe the safeguards that have been established to protect against such occurrences and the contingency and emergency response procedures that would be put in place if such events do occur.	16.1
Of particular concern with exploration drilling in the marine environment is the potential for accidental spills. This includes both low-probability, large-scale events (e.g. blowouts, either surface, sub-sea or underground) and relatively smaller-volume spills that may occur more frequently. These incidents may affect, among other things, the health and survival of plankton, fish eggs and larvae, juvenile and adult fish, marine mammals, marine birds, marine turtles, and marine invertebrates in the affected area, which may include special areas and areas of high ecological significance. Fishing activity, including fishing by Indigenous peoples, and the commercial marketability of seafood products harvested in the Newfoundland and Labrador offshore may also be adversely affected by a spill or blowout. The effects of accidental spills and blowouts will therefore require assessment in the EIS, including fate and behaviour modelling, and hydrologic trajectory modelling for worst-case large-scale spill scenarios that may occur, including any assumptions, limitations, and formulated hypotheses, accompanied by supporting documentation of	16.0 Appendix G

EIS Guidelines Requirements	EIS Section(s)
methodologies and the cumulative results of the modelling. Results should be reported in a manner that illustrates the effects of varying weather and oceanographic conditions that may occur throughout the year, and should include a projection for spills originating at the site and followed until the slick volume is reduced to a negligible amount or until a shoreline is reached. Spill scenarios should also consider potential worst–cases, including when species at risk and high concentrations of marine birds or fish are present or for areas important for reproduction. A discussion on water depth and its effect on blow-out rate and spill trajectory modelling assumptions must be provided. Where well locations have not yet been identified, points of origin selected for spill trajectory models should be conservative (e.g. selecting a potential location within the proposed drilling area that is closest to a sensitive feature or that could result in greatest effects).	
Based on the results of the spill modelling and analysis in the EIS, an emergency response plan (e.g. oil spill contingency plan) for spills (small and large) and blowouts will be required. At a minimum, an outline of the emergency response plan along with key commitments is required in the EIS. Depending on the outcomes of the effects analysis, specific detail on key components of the plan will be required in the EIS. The proponent should commit to finalizing the plan in consultation with regulators prior to the application of permits. The EIS shall include a discussion on the use, availability (including nearest location), timing (testing and mobilizing) and feasibility of a capping stack to stop a blowout and resultant spills. If dispersants are to be used, the proponent shall consider associated environmental effects in the EIS (e.g. effects on marine life) and provide a plan for their use. The environmental effects of other measures outlined in the emergency response plan should also be considered (e.g. effects from burns). The EIS shall include the means by which design and/or operational procedures, including follow-up measures, will be implemented to mitigate significant adverse effects from malfunctions and/or accidental events.	16.1
The potential to encounter shallow gas pockets, and associated implications, should also be discussed.	5.1.3.3 16.2.5 17.1.1
The EIS should also consider effects of accidents in the near-shore environment (e.g. spills and ship groundings, as applicable) and of spills reaching shore; including effects on species at risk and their critical habitat, colonial nesters and concentrations of birds, and their habitat. The proponent will also demonstrate what long-term actions it would be prepared to undertake to remediate spill-affected lands and waters.	16.2 16.3 16.4 16.5 16.6 Appendix G
The EIS should include a summarization of the nature, extent and magnitude of spills, and accidental releases related to existing production installations and past exploration drilling programs in the Newfoundland and Labrador offshore. Comparisons with similar settings (e.g. in the Ormen Lange field in Norway and elsewhere) would also be meaningful for deep water drilling where there is very low probability but very high consequences associated with landsliding.	16.2 16.3 16.4 16.5 16.6 Appendix G
6.6.2 Effects of the environment on the project	
The EIS will take into account how local conditions and natural hazards, such as severe and/or extreme weather conditions and external events (e.g. icebergs, seismic events and submarine landslide potential), could adversely affect the project and how this in turn could result in effects to the environment (e.g. extreme environmental conditions result in malfunctions and accidental events) with consideration of predicted climate change effects.	4.6 17.0

EIS Guidelines Requirements	EIS Section(s)
These events will be considered in different probability patterns (e.g. 5-year event vs. 100-year event).	
The EIS will provide details of planning, design and construction strategies intended to minimize the potential environmental effects of the environment on the project.	17.3
6.6.3 Cumulative effects assessment	
The proponent will identify and assess the project's cumulative effects using the approach described in the Agency's Operational Policy Statement entitled Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012 and the guide entitled Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012	4.4 15.1
Cumulative effects are defined as changes to the environment due to the project combined with the existence of other past, present and reasonably foreseeable physical activities. Cumulative effects may result if:	
– the implementation of the project may cause direct residual adverse effects on the VC, taking into account the application of technically and economically feasible mitigation measures; and, – the same VC may be affected by other past, present and future physical activities.	
VCs that would not be affected by the project or would be affected positively by the project can, therefore, be omitted from the cumulative effects assessment. A cumulative effect on an environmental component may, however, be important even if the assessment of the project's effects on this component reveals that the effects of the project are minor.	15.1.1
In its EIS, the proponent will: –Identify and provide a rationale for the VCs that will constitute the focus of the cumulative effects assessment, focussing the cumulative effects assessment on the VCs most likely to be affected by the project and other project and activities. To this end, the proponent must consider, without limiting itself thereto, the following components likely to be affected by the project:	15.1.1
✓ fish and fish habitat, ✓ migratory birds, ✓ marine mammals and marine turtles, ✓ species at risk, ✓ marine plants, ✓ special areas, ✓ commercial fisheries, ✓ Indigenous peoples, ✓ air quality and greenhouse gases, and ✓ human environment.	
– Identify and justify the spatial and temporal boundaries for the cumulative effect assessment for each VC selected. The boundaries for the cumulative effects assessments will generally be different for each VC considered. These cumulative effects boundaries will also generally be larger than the boundaries for the corresponding project effects.	15.1.2
– Identify the sources of potential cumulative effects. Specify other projects or activities that have been or that are likely to be carried out that could cause	15.1.3

EIS Guidelines Requirements	EIS Section(s)
effects on each selected VC within the boundaries defined, and whose effects would act in combination with the residual effects of the project. This assessment may consider the results of any relevant study conducted by a committee established under section 73 or 74 of CEAA 2012.	
– Assess the cumulative effects on each VC selected by comparing the future scenario with the project and without the project. Effects of past activities (activities that have been carried out) will be used to contextualize the current state of the VC. In assessing the cumulative effects on current use of lands and resources for traditional purposes, the assessment will focus on the cumulative effects on the relevant activity (e.g. fishing).	15.2 15.3 15.4 15.5 15.6 15.7 15.8
– Describe the mitigation measures that are technically and economically feasible. The proponent shall assess the effectiveness of the measures applied to mitigate the cumulative effects. In cases where measures exist that are beyond the scope of the proponent's responsibility that could be effectively applied to mitigate these effects, the proponent will identify these effects and the parties that have the authority to act. In such cases, the EIS will summarize the discussions that took place with the other parties in order to implement the necessary measures over the long term.	15.1.5 15.2 15.3 15.4 15.5 15.6 15.7 15.8
– Determine the significance of the cumulative effects; and	15.1.6 15.2.6 15.3.6 15.4.6 15.5.5 15.6.3 15.7.5 15.8.5
– Develop a follow-up program to verify the accuracy of the assessment or to dispel any uncertainty concerning the effectiveness of mitigation measures for certain cumulative effects.	15.9
The proponent is encouraged to consult with key stakeholders and Indigenous groups prior to finalizing the choice of VCs and the appropriate boundaries to assess cumulative effects.	3.0 4.2
7. SUMMARY OF ENVIRONMENTAL EFFECTS ASSESSMENT	
The EIS will contain a table summarizing the following key information:	18.3
– potential environmental effects on valued components;	
– proposed mitigation measures to address the effects identified above; and	
– potential residual effects and the significance of the residual environmental effects.	
The summary table will be used in the EA Report prepared by the Agency. An example of a format for the key summary table is provided in Appendix 1 of this document.	
In a second table, the EIS will summarize all key mitigation measures and commitments made by the proponent which will more specifically mitigate any significant adverse effects of the project on VCs (i.e. those measures that are essential to ensure that the project will	18.2

EIS Guidelines Requirements	EIS Section(s)
not result in significant adverse environmental effects).	
8. FOLLOW-UP AND MONITORING PROGRAMS	
A follow-up program is designed to verify the accuracy of the effects assessment and to determine the effectiveness of the measures implemented to mitigate the adverse effects of the project. Considerations for developing a follow-up program include: – whether the project will impact environmentally sensitive areas/VCs or protected areas or areas under consideration for protection; – the nature of Indigenous and public concerns raised about the project; – the accuracy of predictions; – whether there is a question about the effectiveness of mitigation measures or the proponent proposes to use new or unproven techniques and technology; – the nature of cumulative environmental effects; – the nature, scale and complexity of the program; and – whether there was limited scientific knowledge about the effects in the EA. – whether there was limited scientific knowledge about the effects in the EA. The goal of a monitoring program is to ensure that proper measures and controls are in place in order to decrease the potential for environmental degradation during all phases of project development, and to provide clearly defined action plans and emergency response procedures to account for human and environmental health and safety.	4.3.4 8.6 9.6 10.6 11.5 12.5 13.5 14.5 15.9 18.4
8.1. Follow-up program	
The duration of the follow-up program shall be as long as required to evaluate the effectiveness of the mitigation measures. The EIS shall present a preliminary follow-up program and shall include: – objectives of the follow-up program and the VCs targeted by the program; – list of elements requiring follow-up; – number of follow-up studies planned as well as their main characteristics (list of parameters to be measured, planned implementation timetable, etc.); – intervention mechanism used in the event that an unexpected deterioration of the environment is observed; – mechanism to disseminate follow-up results among the concerned populations; – accessibility and sharing of data for the general population; – opportunity for the proponent to include the participation of Indigenous groups and stakeholders on the affected territory, during the development and implementation of the program; and – involvement of local and regional organizations in the design, implementation and evaluation of the follow-up results as well as any updates, including a communication mechanism between these organizations and the proponent. The discussion / description of follow-up and monitoring programs relative to the currently proposed drilling program should include a short summary of the design and results/outcomes of monitoring programs that have been undertaken for previously assessed and/or completed offshore exploration drilling programs in similar environments and how these will be factored into the verification of impact predictions and design of the follow-up and monitoring for the current exploration drilling program.	4.3.4 8.6 9.6 10.6 11.5 12.5 13.5 14.5 15.9 18.4
8.2. Monitoring	
The proponent will prepare an environmental monitoring program for all phases of the project.	4.3.4 8.6

EIS Guidelines Requirements	EIS Section(s)
Specifically, the environmental impact statement shall present an outline of the preliminary environmental monitoring program, including the:	9.6 10.6 11.5 12.5 13.5 14.5 15.9 18.4
– identification of the interventions that pose risks to one or more of the environmental and/or valued components and the measures and means planned to protect the environment;	
– identification of regulatory instruments that include a monitoring program requirement for the valued components;	
– description of the characteristics of the monitoring program where foreseeable (e.g. location of interventions, planned protocols, list of measured parameters, analytical methods employed, schedule, human and financial resources required);	
– description of the proponent's intervention mechanisms in the event of the observation of non-compliance with the legal and environmental requirements or with the obligations imposed on contractors by the environmental provisions of their contracts;	
– guidelines for preparing monitoring reports (number, content, frequency, format) that will be sent to the authorities concerned; and	
– plans to engage Indigenous groups in monitoring, where appropriate.	3.3.8 12.5

TABLE OF CONTENTS

Page No.

1 INTRODUCTION 1
1.1 Identification and Overview of the Proponent 1
1.1.1 Nexen's Offshore Experience 2
1.1.2 Health, Safety, Environment and Assurance 2
1.1.3 Nexen Contacts 3
1.2 Project Location and Overview 4
1.2.1 Project Location 4
1.2.2 Key Project Components and Activities 6
1.2.3 Project Environmental Setting and Context 7
1.3 Regulatory Framework and the Role of Government 10
1.3.1 Environmental Assessment under CEAA 2012 10
1.3.2 The Accord Acts 11
1.3.2.1 Land Tenure and Licencing 11
1.3.2.2 Authorizations and Approvals 12
1.3.3 Other Potential Regulatory and Policy Requirements and Interests 14
1.4 Purpose and Organization of the EIS 15
1.5 Key Legislation, Regulations and Associated Approvals 17
1.6 References 26
2 PROJECT DESCRIPTION 27
2.1 Project Scope and Overview 27
2.2 Project Purpose and Benefits 28
2.3 Project Location and Designated Project Area 31
2.4 Adjacent Resource Uses 35
2.5 Project Components and Activities 35
2.5.1 MODU Selection Process and Possible Drilling Units 36
2.5.2 Planned Project Activities 39
2.5.2.1 MODU Mobilization 39
2.5.2.2 Offshore Well Drilling 39
2.5.2.3 Vertical Seismic Profiling 42
2.5.2.4 Well Testing 42
2.5.2.5 Well Abandonment or Suspension 43
2.5.2.6 Supply and Servicing 44
2.6 Project Personnel 47
2.7 Project Schedule 47
2.8 On-Going and Future Project Planning 48
2.8.1 Project Design Changes as a Results of EA Findings 49
2.8.2 Project Planning, Assessment, and Implementation: Application of the Precautionary Principle 49
2.9 Potential Environmental Emissions and Waste Management 51
2.9.1 Air Emissions 52
2.9.2 Drilling Wastes (Fluids, Cuttings, Cement) 52
2.9.2.1 Drilling Fluid Types and Their Composition and Use 52
2.9.2.2 Composition and Toxicity of SBMs Used Offshore Newfoundland 53
2.9.2.3 Drill Fluids and Cuttings 55
2.9.2.4 Cement 56

2.9.3 BOP Fluid Discharges 57
2.9.4 Other Liquid and Solid Waste Materials 58
2.9.5 Sound Emissions 60
2.9.6 Heat and Light Emissions 60
2.10 Alternative Means of Carrying Out the Project 61
2.10.1 Drilling Fluids Selection 62
2.10.2 MODU Selection 63
2.10.3 Drilling Waste Management 64
2.10.4 Water Management and Location of Final Effluent Discharge Points 66
2.10.5 Offshore Lighting 66
2.10.6 Well Testing – Nighttime Flaring 67
2.10.7 Chemical Selection 68
2.11 References 69
3 GOVERNMENTAL, INDIGENOUS AND STAKEHOLDER ENGAGEMENT 72
3.1 EIS Guidelines 72
3.2 Government Departments and Agencies 73
3.3 Indigenous Groups 76
3.3.1 Overview of Nexen's Indigenous Engagement for the EIS 77
3.3.2 Indigenous Traditional Knowledge 79
3.3.3 Newfoundland and Labrador Indigenous Groups 81
3.3.3.1 Labrador Inuit (Nunatsiavut Government) 81
3.3.3.2 Labrador Innu (Innu Nation) 82
3.3.3.3 NunatuKavut Community Council 82
3.3.3.4 Miawpukek First Nation 83
3.3.3.5 Qalipu Mi'kmaq First Nation Band 84
3.3.4 Nova Scotia Indigenous Groups 85
3.3.5 New Brunswick Indigenous Groups 87
3.3.6 Prince Edward Island Indigenous Groups 89
3.3.7 Quebec Indigenous Groups 90
3.3.8 Planned Future Engagement with Indigenous Groups 91
3.4 Stakeholder Organizations 92
4 ENVIRONMENTAL ASSESSMENT SCOPE, FOCUS AND APPROACH 96
4.1 Scope of the Environmental Assessment and Factors Considered 96
4.2 Identification of Valued Components 98
4.3 Environmental Effects Assessment (Planned Project Components and Activities) 104
4.3.1 Environmental Assessment Study Areas and Effects Evaluation Criteria 105
4.3.1.1 Study Areas 105
4.3.1.2 Significance Criteria 109
4.3.2 Potential Environmental Changes, Effects and Associated Parameters 110
4.3.3 Environmental Effects Assessment and Mitigation 110
4.3.4 Environmental Monitoring and Follow-up 114
4.4 Cumulative Environmental Effects 115
4.5 Accidental Events 115
4.6 Effects of the Environment on the Project 116
4.7 References 116
5 EXISTING PHYSICAL ENVIRONMENT 117
5.1 Geology and Geomorphology 117

5.1.1 Bedrock Geology 117
5.1.2 Geomorphology and Surficial Geology 119
5.1.3 Geohazards 123
5.1.3.1 Seismicity 123
5.1.3.2 Slope Instability and Faulting 125
5.1.3.3 Shallow Gas and Gas Hydrates 125
5.1.3.4 Tsunamis 125
5.2 Bathymetry 126
5.3 Climatology 129
5.3.1 Wind Speed and Direction 129
5.3.2 Air Temperature 133
5.3.3 Precipitation 135
5.3.4 Fog and Visibility 137
5.4 Air Quality 139
5.5 Oceanography 140
5.5.1 Waves 140
5.5.2 Ocean Currents 143
5.5.3 Extreme Events 155
5.5.4 Seawater Properties (Temperature, Salinity, pH, Turbidity) 155
5.5.5 Tides 160
5.5.6 Storm Surge 160
5.5.7 Underwater Ambient Noise 160
5.5.7.1 Ambient Sound Pressure Level versus Time 163
5.5.7.2 Spectral Levels and 1/3-Octave Band Levels 163
5.5.7.3 Daily Sound Exposure from Anthropogenic Sources 163
5.6 Ice Conditions 164
5.6.1 Sea Ice 164
5.6.2 Icebergs 172
5.7 Climate Change 176
5.7.1 Atmospheric Climate Changes 176
5.7.1.1 Wind 176
5.7.1.2 Temperature 179
5.7.1.3 Precipitation 179
5.7.1.4 Storms 179
5.7.2 Oceanographic Changes 179
5.7.2.1 Ocean-Water Temperatures 179
5.7.2.2 Waves 182
5.7.2.3 Currents 184
5.7.2.4 Sea Level 185
5.7.3 Ice Conditions 185
5.7.3.1 Sea Ice 185
5.7.3.2 Icebergs 186
5.8 References 186
6 EXISTING BIOLOGICAL ENVIRONMENT 192
6.1 Marine Fish and Fish Habitat 192
6.1.1 Key Data Sources and Administrative Considerations 192
6.1.2 Use and Adequacy of Existing Environmental Information for EIS Purposes 195

6.1.3 The Offshore Marine Ecosystem, Ecological Regimes and Assemblages 196
6.1.4 Plankton 197
6.1.5 Plants and Macroalgae 200
6.1.6 Benthic Invertebrates 200
6.1.6.1 Grand Banks Shelf 200
6.1.6.2 Flemish Cap 203
6.1.6.3 Flemish Pass 204
6.1.6.4 Key Invertebrate Species 205
6.1.6.5 Corals and Sponges 209
6.1.6.6 Invertebrate Reproduction 226
6.1.7 Finfish 227
6.1.7.1 Grand Banks Shelf and Flemish Pass 227
6.1.7.2 Flemish Cap 231
6.1.7.3 Key Fish Species Distributions 232
6.1.7.4 Spawning 256
6.1.7.5 Migration Patterns 257
6.1.8 Species at Risk and Otherwise of Special Conservation Concern 257
6.1.8.1 Wolffish 259
6.1.8.2 American Eel 261
6.1.8.3 White Shark 261
6.1.8.4 Other Sharks 262
6.1.8.5 Thorny Skate 262
6.1.8.6 Atlantic Salmon 263
6.1.8.7 Atlantic Bluefin Tuna 269
6.1.8.8 Grenadier 269
6.1.8.9 Atlantic Cod 270
6.1.8.10 White Hake 270
6.1.8.11 Redfish 270
6.1.9 Aquatic Invasive Species 281
6.1.10 Identified Important and Sensitive Ecological Environments 281
6.1.11 Other Ecologically Important Habitats 281
6.2 Marine and Migratory Birds 285
6.2.1 Approach and Key Information Sources 285
6.2.2 Seabirds 286
6.2.2.1 Cormorants 287
6.2.2.2 Gannets 288
6.2.2.3 Phalaropes 288
6.2.2.4 Gulls 288
6.2.2.5 Terns 289
6.2.2.6 Alcids 289
6.2.2.7 Jaegers and Skuas 289
6.2.2.8 Fulmars and Shearwaters 290
6.2.2.9 Storm-petrels 290
6.2.3 Waterfowl and Divers 290
6.2.4 Shorebirds 292
6.2.5 Other Marine-Associated Avifauna 293
6.2.6 Species at Risk and Otherwise of Special Conservation Concern 293

6.2.7 Important Times and Areas for Marine and Migratory Birds 299
6.2.7.1 Temporal Considerations 299
6.2.7.2 Key Areas 302
6.3 Marine Mammals and Sea Turtles 308
6.3.1 Mysticetes 309
6.3.2 Odontocetes 309
6.3.3 Pinnipeds 310
6.3.4 Sea Turtles 310
6.3.5 Species at Risk and Otherwise of Special Conservation Concern 317
6.3.6 Important Areas and Times for Marine Mammals and Sea Turtles 320
6.4 Special Areas 322
6.4.1 Federally Designated Areas 322
6.4.1.1 Bioregions and Large Ocean Management Areas 322
6.4.1.2 Ecologically and Biologically Significant Areas 324
6.4.1.3 Marine Protected Areas and Areas of Interest 327
6.4.1.4 Marine Refuges 327
6.4.1.5 Fishing Closure Areas within Canada's Exclusive Economic Zone 328
6.4.1.6 National Marine Conservation Areas and Preliminary Representative Marine Areas 329
6.4.1.7 National Wildlife Areas, Marine Wildlife Areas and Migratory Bird Sanctuaries 332
6.4.1.8 National Parks and Historic Sites 333
6.4.2 Provincially Designated Areas 335
6.4.2.1 Wilderness and Ecological Reserves 335
6.4.2.2 Parks and Protected Areas 337
6.4.2.3 Historic Sites 337
6.4.3 Internationally Designated Areas 338
6.4.3.1 Vulnerable Marine Ecosystems 338
6.4.3.2 NAFO Fisheries Closure Areas 342
6.4.4 Other Identified Special Areas 347
6.4.4.1 Important Bird Areas 347
6.4.4.2 World Heritage Sites 351
6.4.4.3 Convention on Wetlands of International Importance 351
6.4.4.4 Western Hemisphere Shorebird Reserve Network 351
6.4.4.5 The UNESCO World Biosphere Reserve Program 352
6.5 References 352
7 EXISTING HUMAN ENVIRONMENT 376
7.1 Eastern Newfoundland – Socioeconomic Overview 376
7.1.1 Population 380
7.1.2 Economy, Employment and Business 381
7.1.3 Regional Services and Infrastructure 386
7.1.3.1 Transportation 386
7.1.3.2 Utilities 386
7.1.3.3 Waste Management 386
7.1.3.4 Education 387
7.1.3.5 Healthcare 387
7.1.3.6 Safety and Security Services 388

7.1.4 Health and Well-Being 388
7.2 Marine Fisheries 391
7.2.1 Management Regimes and Administrative Boundaries 391
7.2.2 Key Information Sources 391
7.2.3 Overview of Past Commercial (Domestic) Fisheries 395
7.2.4 Current Commercial (Domestic) Fisheries 400
7.2.4.1 Harvest Composition and Values 400
7.2.4.2 Harvesting Locations 404
7.2.4.3 Fishing Gear 409
7.2.4.4 Seasonality 415
7.2.4.5 Key Fisheries 430
7.2.5 Indigenous Fisheries 446
7.2.6 Regional Commercial (Domestic) Fisheries 447
7.2.6.1 Harvest Composition and Values 447
7.2.6.2 Harvesting Locations 450
7.2.6.3 Fishing Gear 450
7.2.6.4 Seasonality 452
7.2.7 Recreational Fisheries 454
7.2.8 Potential Future Domestic Fisheries 454
7.2.9 Commercial Fishing by Other Countries 455
7.2.10 Industry and DFO Research Surveys 463
7.2.10.1 DFO Multispecies Research Vessel (RV) Trawl Surveys 463
7.2.10.2 Industry - DFO Collaborative Post-Season Snow Crab Trap Survey 464
7.2.10.3 CAPP Northern Shrimp Survey 466
7.2.10.4 Groundfish Enterprise Allocation Council Survey 466
7.2.10.5 Industry – DFO Shark Survey 466
7.2.10.6 Industry-DFO Atlantic Halibut Survey 466
7.2.11 Sealing 468
7.2.12 Aquaculture 468
7.3 Other Marine Components and Activities 468
7.3.1 Marine Shipping and Transportation 468
7.3.1.1 Port of St. John's 473
7.3.1.2 Ferry Services 474
7.3.1.3 Small Craft Harbours 474
7.3.1.4 Marine Traffic Management 476
7.3.2 Petroleum Exploration and Production Activity 478
7.3.3 Military Activities 481
7.3.4 Unexploded Ordnances and Legacy Sites 481
7.3.5 Federal Lands, and Lands Located Outside the Province or Canada 484
7.3.6 Subsea Cables 486
7.3.7 Coastal and Marine-Based Tourism and Recreation 488
7.3.8 Physical and Cultural Heritage 490
7.3.9 Recreational Hunting and Gathering 492
7.4 Indigenous Peoples 494
7.4.1 Overview of Food, Social and Ceremonial (FSC) and Commercial-Communal Fishing 495
7.4.2 Key Information Sources 497

7.4.3 Newfoundland and Labrador Indigenous Groups 498
7.4.3.1 Labrador Inuit (Nunatsiavut Government) 501
7.4.3.2 Labrador Innu (Innu Nation) 506
7.4.3.3 NunatuKavut Community Council 512
7.4.3.4 Miawpukek First Nation 516
7.4.3.5 Qalipu Mi'kmaq First Nation 517
7.4.4 Mi'kmaq First Nations of Nova Scotia 519
7.4.4.1 Acadia First Nation 522
7.4.4.2 Annapolis Valley First Nation 524
7.4.4.3 Bear River First Nation 525
7.4.4.4 Eskasoni First Nation 527
7.4.4.5 Glooscap First Nation 528
7.4.4.6 Membertou First Nation 530
7.4.4.7 Paqtnkek Mi'kmaw First Nation 532
7.4.4.8 Pictou Landing First Nation 533
7.4.4.9 Potlotek First Nation 535
7.4.4.10 Wagmatcook First Nation 537
7.4.4.11 Waycobah First Nation 538
7.4.4.12 Millbrook First Nation 540
7.4.4.13 Sipekne'katik First Nation 542
7.4.4.14 Traditional Use / Fisheries Studies Undertaken as Part of Recent Offshore Exploration Drilling Projects in Atlantic Canada 543
7.4.5 Mi'kmaq First Nations of New Brunswick 545
7.4.5.1 Fort Folly First Nation 547
7.4.5.2 Eel Ground First Nation 548
7.4.5.3 Pabineau First Nation 549
7.4.5.4 Esgenoôpetitj First Nation 551
7.4.5.5 Bouctouche First Nation 552
7.4.5.6 Indian Island First Nation 554
7.4.5.7 Eel River Bar First Nation 555
7.4.5.8 Metepenagiag Mi'kmaq First Nation 557
7.4.5.9 Elsipogtog First Nation 558
7.4.6 Maliseet First Nations of New Brunswick 560
7.4.6.1 Kingsclear First Nation 561
7.4.6.2 Madawaska Maliseet First Nation 562
7.4.6.3 Oromocto First Nation 563
7.4.6.4 Saint Mary's First Nation 565
7.4.6.5 Tobique First Nation 567
7.4.6.6 Woodstock First Nation 568
7.4.7 Peskotomuhkati Nation (Passamaquoddy) of New Brunswick 570
7.4.8 Mi'kmaq First Nations of Prince Edward Island 572
7.4.8.1 Abegweit First Nation 574
7.4.8.2 Lennox Island First Nation 575
7.4.9 Mi'kmaq First Nations of Québec 577
7.4.9.1 Micmacs of Gesgapegiag 579
7.4.9.2 La Nation Micmac de Gespeg 581
7.4.9.3 Listuguj Mi'gmaq Government 583

7.4.10 Innu First Nations of Québec 585
7.4.10.1 Innu de Ekuanitshit 586
7.4.10.2 Montagnais de Natashquan 591
7.5 References 595
7.5.1 Personal Communications 595
7.5.2 Literature Cited 596
8 MARINE FISH AND FISH HABITAT: ENVIRONMENTAL EFFECTS ASSESSMENT 614
8.1 Environmental Assessment Study Areas and Effects Evaluation Criteria 614
8.1.1 Spatial Boundaries 614
8.1.2 Temporal Boundaries 616
8.1.3 Environmental Effect Significance Definitions 617
8.2 Potential Environmental Changes, Effects and Associated Parameters 617
8.3 Environmental Effects Assessment and Mitigation 620
8.3.1 Approach and Methods 620
8.3.2 Summary of Key Mitigation 621
8.3.3 Presence and Operation of MODUs 623
8.3.3.1 Overview of Potential Effects and Existing Knowledge 624
8.3.3.2 Residual Environmental Effects Assessment 626
8.3.4 Drilling and Associated Marine Discharges 628
8.3.4.1 Overview of Potential Effects and Existing Knowledge 629
8.3.4.2 Residual Environmental Effects Assessment 633
8.3.5 Vertical Seismic Profiling 643
8.3.5.1 Overview of Potential Effects and Existing Knowledge 643
8.3.5.2 Residual Environmental Effects Assessment 650
8.3.6 Well Testing 650
8.3.6.1 Overview of Potential Effects and Existing Knowledge 650
8.3.6.2 Residual Environmental Effects Assessment 651
8.3.7 Well Abandonment or Suspension 651
8.3.7.1 Overview of Potential Effects and Existing Knowledge 652
8.3.7.2 Residual Environmental Effects Assessment 652
8.3.8 Supply and Servicing 653
8.3.8.1 Overview of Potential Effects and Existing Knowledge 653
8.3.8.2 Residual Environmental Effects Assessment 653
8.4 Species at Risk: Overview of Potential Effects and Key Mitigation 654
8.4.1 Wolffish 658
8.4.2 Grenadiers and Thorny Skate 658
8.4.3 Atlantic Cod 659
8.4.4 Atlantic Salmon 659
8.4.4.1 Labrador and Nunavik Populations 659
8.4.4.2 Insular Newfoundland Populations 660
8.4.4.3 Gulf of St. Lawrence Populations 661
8.4.4.4 Eastern - Southern Nova Scotia and Outer Bay of Fundy Populations 662
8.4.4.5 Inner Bay of Fundy Population 663
8.4.5 American Eel 663
8.4.6 Redfish 664
8.4.7 Pelagic Species (Sharks and Tuna) 664
8.5 Environmental Effects Evaluation 664

8.5.1 Residual Environmental Effects Summary 664
8.5.2 Determination of Significance 671
8.6 Environmental Monitoring and Follow-up 671
8.7 References 672
9 MARINE AND MIGRATORY BIRDS: ENVIRONMENTAL EFFECTS ASSESSMENT 689
9.1 Environmental Assessment Study Areas and Effects Evaluation Criteria 689
9.1.1 Spatial Boundaries 689
9.1.2 Temporal Boundaries 691
9.1.3 Environmental Effect Significance Definitions 691
9.2 Potential Environmental Changes, Effects and Associated Parameters 692
9.3 Environmental Effects Assessment and Mitigation 695
9.3.1 Approach and Methods 695
9.3.2 Summary of Key Mitigation 695
9.3.3 Presence and Operation of MODUs 696
9.3.3.1 Overview of Potential Effects and Existing Knowledge 697
9.3.3.2 Residual Environmental Effects Assessment 698
9.3.4 Drilling and Associated Marine Discharges 700
9.3.4.1 Overview of Potential Effects and Existing Knowledge 700
9.3.4.2 Residual Environmental Effects Assessment 701
9.3.5 Vertical Seismic Profiling 703
9.3.5.1 Overview of Potential Effects and Existing Knowledge 703
9.3.5.2 Residual Environmental Effects Assessment 704
9.3.6 Well Testing 705
9.3.6.1 Overview of Potential Effects and Existing Knowledge 705
9.3.6.2 Residual Environmental Effects Assessment 705
9.3.7 Well Abandonment or Suspension 706
9.3.8 Supply and Servicing 706
9.3.8.1 Overview of Potential Effects and Existing Knowledge 706
9.3.8.2 Residual Environmental Effects Assessment 707
9.4 Species at Risk: Overview of Potential Effects and Key Mitigation 709
9.5 Environmental Effects Evaluation 712
9.5.1 Residual Environmental Effects Summary 712
9.5.2 Determination of Significance 717
9.6 Environmental Monitoring and Follow-up 717
9.7 References 718
10 MARINE MAMMALS AND SEA TURTLES: ENVIRONMENTAL EFFECTS ASSESSMENT 725
10.1 Environmental Assessment Study Areas and Effects Evaluation Criteria 725
10.1.1 Spatial Boundaries 725
10.1.2 Temporal Boundaries 727
10.1.3 Environmental Effect Significance Definitions 727
10.2 Potential Environmental Changes, Effects and Associated Parameters 728
10.3 Environmental Effects Assessment and Mitigation 730
10.3.1 Approach and Methods 730
10.3.2 Summary of Key Mitigation 731
10.3.3 Presence and Operation of MODUs 732
10.3.3.1 Overview of Potential Effects and Existing Knowledge 732
10.3.3.2 Residual Environmental Effects Assessment 735

10.3.4 Drilling and Associated Marine Discharges 736
10.3.4.1 Overview of Potential Effects and Existing Knowledge 736
10.3.4.2 Residual Environmental Effects Assessment 737
10.3.5 Vertical Seismic Profiling 737
10.3.5.1 Overview of Potential Effects and Existing Knowledge 737
10.3.5.2 Residual Environmental Effects Assessment 740
10.3.6 Well Testing 741
10.3.7 Well Abandonment or Suspension 742
10.3.8 Supply and Servicing 742
10.3.8.1 Overview of Potential Effects and Existing Knowledge 742
10.3.8.2 Residual Environmental Effects Assessment 743
10.4 Species at Risk: Overview of Potential Effects and Key Mitigation 744
10.5 Environmental Effects Evaluation 746
10.5.1 Residual Environmental Effects Summary 746
10.5.2 Determination of Significance 752
10.6 Environmental Monitoring and Follow-Up 752
10.7 References 753
11 SPECIAL AREAS: ENVIRONMENTAL EFFECTS ASSESSMENT 764
11.1 Environmental Assessment Study Areas and Effects Evaluation Criteria 764
11.1.1 Spatial Boundaries 764
11.1.2 Temporal Boundaries 766
11.1.3 Environmental Effect Significance Definitions 766
11.2 Potential Environmental Changes, Effects and Associated Parameters 767
11.3 Environmental Effects Assessment and Mitigation 768
11.3.1 Approach and Methods 768
11.3.2 Summary of Key Mitigation 769
11.3.3 Environmental Effects Assessment (All Planned Components and Activities) 769
11.4 Environmental Effects Evaluation 778
11.5 Environmental Monitoring and Follow-up 778
12 INDIGENOUS PEOPLES: ENVIRONMENTAL EFFECTS ASSESSMENT 782
12.1 Environmental Assessment Study Areas and Effects Evaluation Criteria 783
12.1.1 Spatial Boundaries 783
12.1.2 Temporal Boundaries 785
12.1.3 Environmental Effect Significance Definitions 785
12.2 Potential Environmental Changes, Effects and Associated Parameters 785
12.3 Environmental Effects Assessment and Mitigation 791
12.3.1 Approach and Methods 791
12.3.2 Summary of Key Mitigation 791
12.3.3 Environmental Effects Assessment (All Planned Components and Activities) 792
12.3.3.1 Health and Socio-Economic Conditions 792
12.3.3.2 Current Use of Lands and Resources for Traditional Purposes 792
12.3.3.3 Physical and Cultural Heritage (Including Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance) 816
12.4 Environmental Effects Evaluation 816
12.4.1 Residual Environmental Effects Summary 816
12.4.2 Determination of Significance 820
12.5 Environmental Monitoring and Follow-up 820

12.6 References 821
13 FISHERIES AND OTHER OCEAN USES: ENVIRONMENTAL EFFECTS ASSESSMENT ... 828
13.1 Environmental Assessment Study Areas and Effects Evaluation Criteria 828
13.1.1 Spatial Boundaries 829
13.1.2 Temporal Boundaries 831
13.1.3 Environmental Effect Significance Definitions 831
13.2 Potential Environmental Changes, Effects and Associated Parameters 831
13.2.1 Fisheries 833
13.2.2 Other Ocean Uses 833
13.3 Environmental Effects Assessment and Mitigation 836
13.3.1 Approach and Methods 836
13.3.2 Summary of Key Mitigation 836
13.3.2.1 Fisheries 837
13.3.2.2 Other Ocean Uses 838
13.3.3 Presence and Operation of MODUs 838
13.3.4 Drilling and Associated Marine Discharges 840
13.3.5 Vertical Seismic Profiling 841
13.3.6 Well Testing 842
13.3.7 Well Abandonment or Suspension 842
13.3.8 Supply and Servicing 843
13.4 Environmental Effects Evaluation 844
13.4.1 Residual Environmental Effects Summary 844
13.4.2 Determination of Significance 851
13.5 Environmental Monitoring and Follow-up 851
14 ATMOSPHERIC ENVIRONMENT: ENVIRONMENTAL EFFECTS ASSESSMENT 852
14.1 Environmental Assessment Study Areas and Effects Assessment Criteria 852
14.1.1 Spatial Boundaries 852
14.1.2 Temporal Boundaries 854
14.1.3 Environmental Effect Significance Definitions 854
14.2 Potential Environmental Changes, Effects and Associated Parameters 855
14.3 Environmental Effects Assessment and Mitigation 856
14.3.1 Approach and Methods 856
14.3.2 Summary of Key Mitigation 856
14.3.3 Presence and Operation of MODUs 857
14.3.3.1 Semi-Submersible MODU Option 857
14.3.3.2 Drill Ship MODU Option 858
14.3.4 Well Testing 859
14.3.5 Supply and Servicing 860
14.3.5.1 Vessels 860
14.3.5.2 Aircraft 861
14.3.6 Summary 863
14.3.7 Greenhouse Gases 863
14.4 Environmental Effects Evaluation 865
14.4.1 Regulatory and Policy Contexts 865
14.4.2 Residual Environmental Effects Summary 865
14.4.3 Determination of Significance 866
14.5 Environmental Monitoring and Follow-up 866

14.6 References 870
15 CUMULATIVE ENVIRONMENTAL EFFECTS 871
15.1 Approach and Methods 871
15.1.1 Identification of Valued Components 871
15.1.2 Spatial and Temporal Boundaries 873
15.1.3 Sources of Potential Cumulative Effects 874
15.1.4 Assessing Cumulative Effects on Each VC 879
15.1.5 Mitigation 880
15.1.6 Determination of Significance 880
15.1.7 Follow-up 881
15.2 Marine Fish and Fish Habitat (including Species at Risk) 881
15.2.1 Past and On-going Effects (Baseline) 881
15.2.2 Potential Project-Related Contributions to Cumulative Effects 882
15.2.3 On-Going and Future Projects and Activities and Their Effects 882
15.2.4 Potential Cumulative Environmental Effects 886
15.2.5 Species at Risk 887
15.2.6 Cumulative Effects Summary and Evaluation 887
15.3 Marine and Migratory Birds (including Species at Risk) 889
15.3.1 Past and On-going Effects (Baseline) 889
15.3.2 Potential Project-Related Contributions to Cumulative Effects 889
15.3.3 On-Going and Future Projects and Activities and Their Effects 890
15.3.4 Potential Cumulative Environmental Effects 892
15.3.5 Species at Risk 893
15.3.6 Cumulative Effects Summary and Evaluation 894
15.4 Marine Mammals and Sea Turtles (including Species at Risk) 895
15.4.1 Past and On-going Effects (Baseline) 895
15.4.2 Potential Project-Related Contributions to Cumulative Effects 896
15.4.3 On-Going and Future Projects and Activities and Their Effects 896
15.4.4 Potential Cumulative Environmental Effects 898
15.4.5 Species at Risk 899
15.4.6 Cumulative Effects Summary and Evaluation 899
15.5 Special Areas 901
15.5.1 Past and On-going Effects (Baseline) 901
15.5.2 Potential Project-Related Contributions to Cumulative Effects 902
15.5.3 On-Going and Future Projects and Activities and Their Effects 902
15.5.4 Potential Cumulative Environmental Effects 903
15.5.5 Cumulative Effects Summary and Evaluation 904
15.6 Indigenous Peoples 906
15.6.1 Past and On-going Effects (Baseline) 906
15.6.2 Potential Project-Related Contributions to Cumulative Effects 906
15.6.3 Cumulative Effects Summary and Evaluation 907
15.7 Fisheries and Other Ocean Uses 908
15.7.1 Past and On-going Effects (Baseline) 908
15.7.2 Potential Project-Related Contributions to Cumulative Effects 908
15.7.3 On-Going and Future Projects and Activities and Their Effects 909
15.7.4 Potential Cumulative Environmental Effects 911
15.7.5 Cumulative Effects Summary and Evaluation 912

15.8 Atmospheric Environment 913
15.8.1 Past and On-going Effects (Baseline) 913
15.8.2 Potential Project-Related Contributions to Cumulative Effects 914
15.8.3 On-Going and Future Projects and Activities and Their Effects 914
15.8.4 Potential Cumulative Environmental Effects 915
15.8.5 Cumulative Effects Summary and Evaluation 915
15.9 Monitoring and Follow-up 917
15.10 References 917
16 ACCIDENTAL EVENTS 920
16.1 Spill Prevention and Response 920
16.1.1 Accident Prevention 920
16.1.1.1 Leadership and Safety Culture 921
16.1.1.2 Competency and Training 921
16.1.2 Process Safety Management 921
16.1.2.1 Risk Management 922
16.1.2.2 Asset Integrity and Reliability 923
16.1.2.3 Financial Responsibility 924
16.1.3 Nexen Global Drilling and Completions Governance 924
16.1.3.1 Well Delivery Process 925
16.1.4 Contingency Planning and Emergency Response 925
16.1.4.1 Nexen Emergency Response Hierarchy 925
16.1.4.2 Emergency Response Contingency Plans 927
16.1.4.3 Potential OSRP Tactics 930
16.1.5 Applicable Regulatory Requirements 932
16.2 Potential Accidental Event Scenarios 932
16.2.1 Vessel Collision 933
16.2.2 Dropped Objects 934
16.2.3 Loss of MODU Stability or Station Keeping 935
16.2.4 Loss of Well Control 935
16.2.5 Potential Spill Scenarios 936
16.2.5.1 Marine Diesel Spills 937
16.2.5.2 Subsurface Blowout 937
16.2.5.3 Drill Fluid (SBM) Spill 937
16.2.5.4 Potential Nearshore Accidental Events 937
16.3 Spill Risk and Probabilities 938
16.3.1 Historical Spill Data - Canada-NL Offshore Area 938
16.3.2 Calculated Probabilities of Spills from the Project 945
16.4 Fate and Behaviour of Potential Oil Spills 946
16.4.1 Locations and Scenarios 946
16.4.2 Overall Modelling Approach 949
16.4.2.1 Stochastic Approach 949
16.4.2.2 Deterministic Approach 953
16.4.3 Model Input Data 954
16.4.4 Model Results 955
16.4.4.1 Summary of Stochastic Results 956
16.4.4.2 Summary of Deterministic Results 966
16.4.4.3 Marine Diesel Batch Spills 972

16.4.4.4 Vessel Collision Scenario 975
16.4.4.5 Key Uncertainties 976
16.4.4.6 Summary of Modelling Results 977
16.5 Fate and Behaviour of Potential Drill Fluid (SBM) Spills 978
16.6 Environmental Effects Assessment 981
16.6.1 Key Modelling Results Integrated into the Assessment 982
16.6.1.1 Marine Diesel Spills Scenarios (Batch Spills and Vessel Collision Scenarios) 983
16.6.1.2 Drill Fluid (SBM) Spill Scenarios 983
16.6.1.3 Uncontrolled Well Event 983
16.6.1.4 VC-Specific Context 984
16.6.2 Marine Fish and Fish Habitat (including Species at Risk) 986
16.6.2.1 Potential Issues and Interactions 986
16.6.2.2 Environmental Effects Assessment 993
16.6.2.3 Summary and Determination of Significance 997
16.6.3 Marine and Migratory Birds (including Species at Risk) 998
16.6.3.1 Potential Issues and Interactions 999
16.6.3.2 Environmental Effects Assessment 1001
16.6.3.3 Summary and Determination of Significance 1004
16.6.4 Marine Mammals and Sea Turtles (including Species at Risk) 1006
16.6.4.1 Potential Issues and Interactions 1007
16.6.4.2 Environmental Effects Assessment 1009
16.6.4.3 Summary and Determination of Significance 1011
16.6.5 Special Areas 1012
16.6.5.1 Potential Issues and Interactions 1013
16.6.5.2 Environmental Effects Assessment 1014
16.6.5.3 Summary and Determination of Significance 1019
16.6.6 Indigenous Peoples 1021
16.6.6.1 Potential Issues and Interactions 1021
16.6.6.2 Environmental Effects Assessment 1023
16.6.6.3 Summary and Determination of Significance 1026
16.6.7 Fisheries and Other Ocean Uses 1028
16.6.7.1 Potential Issues and Interactions 1029
16.6.7.2 Environmental Effects Assessment 1031
16.6.7.3 Summary and Determination of Significance 1038
16.7 References 1039
17 EFFECTS OF THE ENVIRONMENT ON THE PROJECT 1056
17.1 Key Environmental Considerations 1056
17.1.1 Seismicity and Geohazards 1056
17.1.2 Climatology, Weather and Oceanographic Conditions 1057
17.1.3 Sea Ice and Icebergs 1059
17.1.4 Climate Change 1060
17.2 Assessing Potential Effects of the Environment on the Project 1060
17.2.1 Seismicity and Geohazards 1060
17.2.2 Climatology, Weather and Oceanographic Conditions 1060
17.2.3 Sea Ice and Icebergs 1061
17.3 Mitigating Potential Effects of the Environment on the Project 1061

17.3.1 Seismicity and Geohazards 1062
17.3.2 Climatology, Weather and Oceanographic Conditions 1062
17.3.3 Sea Ice and Icebergs 1064
17.4 Effects Summary and Evaluation 1065
17.5 References 1066
18 EIS SUMMARY AND CONCLUSION 1068
18.1 Summary of Potential Effects 1069
18.2 Summary of Mitigation 1071
18.3 Residual Environmental Effects 1077
18.4 Environmental Monitoring and Follow-up 1083
18.4.1 Follow-up 1083
18.4.2 Future Environmental Monitoring, Observations and Communications 1084
18.4.2.1 Environmental Monitoring and Observations 1084
18.4.2.2 Engagement and Communications 1085
18.4.3 Adaptive Management 1085
18.5 Summary of Predicted Environmental Changes and Effects and Their Relationship to Federal Jurisdiction and Decisions 1086
18.5.1 Changes to Environmental Components within Federal Jurisdiction 1087
18.5.1.1 Planned Project Activities 1087
18.5.1.2 Potential Accidental Events 1088
18.5.1.3 Summary 1089
18.5.2 Changes to the Environment that Would Occur on Federal Lands, in Another Province, or Outside Canada 1089
18.5.2.1 Planned Project Activities 1089
18.5.2.2 Potential Accidental Events 1091
18.5.2.3 Summary 1091
18.5.3 Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions 1092
18.6 Conclusion 1095

LIST OF TABLES

Page No.

Table 1.1 Nexen Exploration Licences Within the Project Area 4
Table 1.2 Summary of Potentially Applicable Legislation, Regulations and Guidelines..... 17
Table 2.1 Nexen Exploration Licences off Eastern Newfoundland..... 34
Table 2.2 Nexen Project Area Corner Point Coordinates..... 34
Table 2.3 Nexen Exploration Licences 1144 and 1150 Coordinates..... 34
Table 2.4 Typical MODU Components and Equipment 38
Table 2.5 Estimated Drill Fluid and Cuttings Discharge Volumes (For Illustration Only) 55
Table 2.6 Estimated Cement Use and Potential Discharges..... 57
Table 2.7 Estimated BOP Control Fluid Use and Potential Discharges 57
Table 2.8 Identification and Evaluation of Drilling Fluid Options 62
Table 2.9 Identification and Evaluation of MODU Options..... 64
Table 2.10 Identification and Evaluation of Drilling Waste Disposal Options..... 66
Table 2.11 Identification and Evaluation of Lighting Options 67
Table 2.12 Identification and Evaluation of Flaring at Night Options..... 68
Table 3.1 Meetings and Discussions with Government Departments and Agencies..... 74
Table 3.2 Engagement Activities with Nunatsiavut Government and Key Outcomes..... 81
Table 3.3 Engagement Activities with Innu Nation and Key Outcomes..... 82
Table 3.4 Engagement Activities with NunatuKavut Community Council and Key Outcomes..... 82
Table 3.5 Engagement Activities with Miawpukek First Nation and Key Outcomes 83
Table 3.6 Engagement Activities with Qalipu Mi'kmaq First Nation Band and Key Outcomes 84
Table 3.7 Engagement Activities with Nova Scotia Indigenous Groups and Key Outcomes 85
Table 3.8 Engagement Activities with New Brunswick Indigenous Groups and Key Outcomes.. 87
Table 3.9 Engagement Activities with Prince Edward Island Indigenous Groups and Key Outcomes 89
Table 3.10 Engagement Activities with Quebec Indigenous Groups and Key Outcomes..... 90
Table 3.11 Meetings and Discussions with Stakeholder Organizations and Key Outcomes 92
Table 4.1 Identified VCs and the Rationale for their Selection..... 99
Table 4.2 Identified VCs and Potential Considerations Relevant to CEAA (2012) 102
Table 4.3 Environmental Assessment Study Areas 106
Table 4.4 Environmental Effect Descriptors..... 112
Table 5.1 Wind Statistics, MSC50 Node M6012613 (1962 – 2015) 131
Table 5.2 Monthly Air Temperature (°C) Statistics..... 134
Table 5.3 Frequency of Occurrence (Percent) of Precipitation and Thunderstorms..... 135
Table 5.4 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility 138
Table 5.5 2015 Facility Reported CAC Emissions (NPRI Reporting) – NL Offshore Production Platforms..... 139
Table 5.6 2015 Facility Reported GHG Emissions (GHGRP) – NL Offshore Production Platforms..... 140
Table 5.7 Wave Statistics, MSC50 Node M6012613 (1962 – 2015) 141
Table 5.8 ODI Ocean Current Statistics Summary (46.4° to 49°N, 45.5° to 47.5°W) 144
Table 5.9 Monthly Current Speed Statistics for EL 1144 Location 148
Table 5.10 Monthly Current Speed Statistics for EL 1150 Location 148
Table 5.11 Extreme Wind and Wave Estimates, MSC50 Node M6012613 (1962–2015)..... 155
Table 5.12 Monthly Sea Temperature Profile Statistics 155
Table 5.13 Monthly Salinity Profile Statistics 157

Table 5.14 Tidal Predictions 160
Table 5.15 Frequency of Presence of Sea Ice (%) 166
Table 5.16 Median of Ice Concentration, When Ice is Present 167
Table 5.17 Median of Predominant Ice Type, When Ice is Present 168
Table 5.18 Stage of Development, Sea Ice 169
Table 6.1 Dominant Infaunal Invertebrate (Abundance) Species Representative of the Grand Bank 201
Table 6.2 Dominant Macrofaunal Invertebrate (Abundance, Catch per Unit Effort, and Biomass) Species Representative of the Grand Bank 202
Table 6.3 Dominant Invertebrate Species Representative of the Flemish Cap and Upper Slope 204
Table 6.4 Dominant Invertebrate Species of the Flemish Pass 204
Table 6.5 Corals Occurring within the Project Area and Adjacent Marine Environments 209
Table 6.6 Coral Percent Presence in Trawls in the Project Area based on Canadian RV Surveys (2005-2015) 213
Table 6.7 Coral Percent Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013) 214
Table 6.8 Sponges Occurring within the Project Area and Adjacent Environments 218
Table 6.9 Sponge Percent Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013) 221
Table 6.10 Known and Potential Presence of Corals and Sponges in the Project Area 223
Table 6.11 Summary of Depth Categories used to Present Canadian RV Survey Data (2008-2012) 228
Table 6.12 Numerically Dominant Fish Species (95% of Overall Abundance) within the Project Area inside the EEZ by Depth Zone (Canadian RV Surveys, 2008-2012) 228
Table 6.13 Numerically Dominant Fish Species (95% of Overall Abundance) in the Flemish Pass Based on Longline Fishing Surveys 230
Table 6.14 Fish Species Associated with Sponge Ground Densities 230
Table 6.15 Abundant Fish by Depth Zone on the Flemish Cap (EU RV Surveys, 2004-2013) 231
Table 6.16 Key Species within the Project Area based on Canadian RV (2008-2012) and EU RV (2004-2013) Surveys 232
Table 6.17 Fish Species at Risk or Otherwise of Special Conservation Concern 258
Table 6.18 Atlantic Salmon Populations / Designatable Units and Their *SARA* and COSEWIC Status in the Western North Atlantic 265
Table 6.19 Identified Special Areas that Overlap with the Project Area and their Relationship to Marine Fish and Fish Habitat 281
Table 6.20 Seabirds that are Known or Likely to Occur in the Project Area and RSA 286
Table 6.21 Overview of Waterfowl and Divers that have Potential to Occur in the Project Area and RSA 291
Table 6.22 Overview of Shorebirds that have Potential to Occur in the Project Area and RSA 293
Table 6.23 Avian Species at Risk and their Likelihood of Occurrence in the Project Area and RSA 294
Table 6.24 IBAs in Eastern Newfoundland and Labrador 302
Table 6.25 Overview of Mysticetes that are Known or Likely to Occur in the Project Area and RSA 309
Table 6.26 Overview of Odontocetes that are Known or Likely to Occur in the Project Area and RSA 309

Table 6.27 Overview of Pinnipeds that are Known or Likely to Occur in the Project Area and RSA 310
Table 6.28 Overview of Sea Turtles that are Known or Likely to Occur in the Project Area and RSA 311
Table 6.29 Marine Mammal and Sea Turtle Species at Risk and their Likelihood of Occurrence 317
Table 6.30 EBSAs and their Relevance to Marine Mammals and Sea Turtles 321
Table 6.31 EBSAs off Eastern Newfoundland 324
Table 6.32 MPAs and AOI in Newfoundland and Labrador 327
Table 6.33 Marine Refuges off Eastern Newfoundland 328
Table 6.34 Federal Fisheries Closure Areas off Eastern Newfoundland 328
Table 6.35 Preliminary RMAs off Eastern Newfoundland 330
Table 6.36 MBSs in Newfoundland and Labrador 332
Table 6.37 Coastal National Parks and Historic Sites in Eastern Newfoundland 333
Table 6.38 Coastal Provincial Ecological Reserves in Eastern Newfoundland 335
Table 6.39 Coastal Provincial Parks and Protected Areas in Eastern Newfoundland 337
Table 6.40 Coastal Provincial Historic Sites in Eastern Newfoundland 338
Table 6.41 VMEs off Eastern Newfoundland 339
Table 6.42 NAFO Fisheries Closure Areas off Eastern Newfoundland 342
Table 6.43 Coastal Important Bird Areas in Newfoundland and Labrador 347
Table 6.44 World Heritage Sites in Newfoundland and Labrador 351
Table 7.1 Population, Eastern Newfoundland Region 380
Table 7.2 Selected Newfoundland and Labrador Economic Indicators 381
Table 7.3 Major Capital Investment Projects in Eastern Newfoundland 382
Table 7.4 Number of Businesses, Eastern Newfoundland (2015) 383
Table 7.5 Number of Businesses by Sector, Eastern Newfoundland (2011 and 2015) 383
Table 7.6 Number of Businesses by Employment Size, Eastern Newfoundland 384
Table 7.7 Labour Market Profile, Eastern Newfoundland (2011) 384
Table 7.8 Employment by Occupation, Eastern Newfoundland (2011) 385
Table 7.9 Personal and Family Income, Eastern Newfoundland (2013) 385
Table 7.10 All Fish Species by Quantity and Value, 2010-2015 Average and 2015 400
Table 7.11 All Fish Species Quantity and Value by Year, Project Area UAs and Adjacent UAs 2010-2015 403
Table 7.12 Harvest Quantity and Value by Fishing Gear Type, Project Area UAs and Adjacent UAs 2010-2015 Average 409
Table 7.13 Regional Snow / Queen Crab Quotas for 2015 and 2017 431
Table 7.14 Status and 2016 Quotas for Key Groundfish Species 437
Table 7.15 NAFO Divisions 3KLMNO by Quantity and Value of Domestic Harvest, All Species 2010-2015 Averages 447
Table 7.16 NAFO Divisions 3KLMNO Quantity and Value of Domestic Harvest by Year, All Species 2010-2015 448
Table 7.17 NAFO Divisions 3KLMNO Quantity and Value of Domestic Harvest by Fishing Gear Type, 2010-2015 Averages 452
Table 7.18 Recreational Groundfish (Food) Fishery (2017) 454
Table 7.19 Quantity of Harvest by Canadian Region and Foreign Nation, NAFO Divisions 3L and 3M 2007–2016 Average and 2016 456
Table 7.20 Foreign (Non-Canadian) Quantity of Harvest by Species, NAFO Divisions 3L and 3M 2007–2016 Average and 2016 457

Table 7.21 NAFO Divisions 3KLMNO Quantity of Harvest by Canadian Region and Foreign Nation, 2007–2016 Average 461
Table 7.22 NAFO Divisions 3KLMNO Foreign Quantity of Harvest by Species, 2007–2016 Average 461
Table 7.23 DFO Research Vessel Surveys within Project Area NAFO Divisions, by Vessel, 2017 464
Table 7.24 DFO Research Vessel Surveys within NAFO Divisions 3KNO, by Vessel, 2017 464
Table 7.25 International Shipping in Eastern Newfoundland (2011) 471
Table 7.26 Domestic Shipping in Eastern Newfoundland (2011) 471
Table 7.27 Port Activity at St. John's Harbour 473
Table 7.28 Oil Production Projects off Eastern Newfoundland 478
Table 7.29 UXOs and Legacy Sites 482
Table 7.30 Top Federal Agencies by Land Area, Number of Properties and Buildings 484
Table 7.31 Marine Cables 486
Table 7.32 Eastern Newfoundland Cruise Ship Activity (2016) 490
Table 7.33 Waterfowl and Murre Hunting (2016-2017) 492
Table 7.34 Indigenous Groups in Eastern Canada Included in the EIS Guidelines 494
Table 7.35 Newfoundland and Labrador Indigenous Communities and Organizations 498
Table 7.36 Socioeconomic Overview of the Labrador Inuit Communities 505
Table 7.37 Socioeconomic Overview of Labrador Innu Communities 510
Table 7.38 Socioeconomic Overview of Southeastern Labrador Communities 515
Table 7.39 Socioeconomic Overview of the Miawpukek First Nation 517
Table 7.40 Socioeconomic Overview of the Qalipu Mi'kmaq First Nation 519
Table 7.41 Socioeconomic Overview of the Acadia First Nation 523
Table 7.42 Socioeconomic Overview of the Annapolis Valley First Nation 525
Table 7.43 Socioeconomic Overview of the Bear River First Nation 526
Table 7.44 Socioeconomic Overview of the Eskasoni First Nation 528
Table 7.45 Socioeconomic Overview of the Glooscap First Nation 529
Table 7.46 Socioeconomic Overview of the Membertou First Nation 531
Table 7.47 Socioeconomic Overview of the Paqtnkek Mi'kmaw Nation 533
Table 7.48 Socioeconomic Overview of the Pictou Landing First Nation 534
Table 7.49 Socioeconomic Overview of the Potlotek First Nation 536
Table 7.50 Socioeconomic Overview of the Wagmatcook First Nation 538
Table 7.51 Socioeconomic Overview of the Waycobah First Nation 539
Table 7.52 Socioeconomic Overview of the Millbrook First Nation 541
Table 7.53 Socioeconomic Overview of the Sipekne'katik First Nation 543
Table 7.54 Socioeconomic Overview of the Fort Folly First Nation 548
Table 7.55 Socioeconomic Overview of the Eel Ground First Nation 549
Table 7.56 Socioeconomic Overview of the Pabineau First Nation 550
Table 7.57 Socioeconomic Overview of the Esgenoôpetitj First Nation 552
Table 7.58 Socioeconomic Overview of the Buctouche First Nation 554
Table 7.59 Socioeconomic Overview of the Indian Island First Nation 555
Table 7.60 Socioeconomic Overview of the Eel River Bar First Nation 556
Table 7.61 Socioeconomic Overview of the Metepenagiag Mi'kmaq First Nation 558
Table 7.62 Socioeconomic Overview of the Elsipogtog First Nation 559
Table 7.63 Socioeconomic Overview of the Kingsclear First Nation 562
Table 7.64 Socioeconomic Overview of the Madawaska Maliseet First Nation 563

Table 7.65 Socioeconomic Overview of the Oromocto First Nation 564
Table 7.66 Socioeconomic Overview of the Saint Mary's First Nation 566
Table 7.67 Socioeconomic Overview of the Tobique First Nation 568
Table 7.68 Socioeconomic Overview of the Woodstock First Nation 569
Table 7.69 Socioeconomic Overview of the Peskotomuhkati Nation 571
Table 7.70 Socioeconomic Overview of the Abegweit First Nation 575
Table 7.71 Socioeconomic Overview of the Lennox Island First Nation 576
Table 7.72 Socioeconomic Overview of the Micmacs de Gesgapegiag 581
Table 7.73 Socioeconomic Overview of the Micmac de Gespeg 582
Table 7.74 Socioeconomic Overview of the Listuguj Mi'gmaq 584
Table 7.75 Summary of Marine Species Harvested by Selected Québec Mi'kmaq Groups 585
Table 7.76 Species Harvested by the Innu de Ekuanitshit (1951-1982) 588
Table 7.77 Socioeconomic Overview of the Innu de Ekuanitshit 590
Table 7.78 Species Harvested by the Montagnais de Natashquan (1951-1982) 592
Table 7.79 Socioeconomic Overview of the Montagnais de Natashquan 594
Table 8.1 Potential Project-Related Environmental Changes and Resulting Effects: Marine Fish and Fish Habitat 618
Table 8.2 Potential Project-VC Interactions and Associated Effects: Marine Fish and Fish Habitat 619
Table 8.3 Cuttings Material and Thickness by Distance: EL 1144 Deepwater Jurassic Example Well 636
Table 8.4 Cuttings Material and Thickness by Distance, EL 1150 Shallow Water Cretaceous Example Well 639
Table 8.5 Marine Fish Species at Risk: Potential Interactions with Project Components by Life History Stage 655
Table 8.6 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects 655
Table 8.7 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat 667
Table 9.1 Potential Project-Related VC Environmental Changes and Resulting Effects: Marine and Migratory Birds 693
Table 9.2 Potential Project-VC Interactions and Associated Effects: Marine and Migratory Birds 694
Table 9.3 Marine and Migratory Bird Species at Risk: Analysis of Potential Environmental Interactions and Effects 709
Table 9.4 Environmental Effects Assessment Summary: Marine and Migratory Birds 713
Table 10.1 Potential Project-Related VC Environmental Changes and Resulting Effects: Marine Mammals and Sea Turtles 729
Table 10.2 Potential Project-VC Interactions and Associated Effects: Marine Mammals and Sea Turtles 730
Table 10.3 Acoustic Threshold Levels for Marine Mammals 734
Table 10.4 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects 744
Table 10.5 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles 749
Table 11.1 Potential Project-Related Environmental Changes and Resulting Effects: Special Areas 767
Table 11.2 Potential Project-VC Interactions and Associated Effects: Special Areas 768
Table 11.3 Special Areas: Summary of Minimum Distances from the LSA, Project Area, ELs 1144

and 1150 and Potential Vessel and Aircraft Route 771
Table 11.4 Environmental Effects Assessment Summary: Special Areas 779
Table 12.1 Potential Project-Related Environmental Changes and Resulting Effects: Indigenous Peoples 789
Table 12.2 Potential Project-VC Interactions and Associated Effects: Indigenous Peoples 790
Table 12.3 Identified Marine-Associated Species: Newfoundland and Labrador Indigenous Groups 795
Table 12.4 Identified Marine-Associated Species: Nova Scotia Indigenous Groups 796
Table 12.5 Identified Marine-Associated Species: New Brunswick Indigenous Groups 798
Table 12.6 Identified Marine-Associated Species: PEI and Quebec Indigenous Groups 799
Table 12.7 Identified Species and their Potential for Interaction with the Project (LSA Occurrence) 801
Table 12.8 Atlantic Salmon Populations / Designatable Units and their SARA and COSEWIC Status 810
Table 12.9 Atlantic Salmon Populations Used by Indigenous Groups and their Potential for Interaction with the Project 811
Table 12.10 Environmental Effects Assessment Summary: Indigenous Peoples 818
Table 13.1 Potential Project-Related Environmental Changes and Resulting Effects: Fisheries 833
Table 13.2 Potential Project-Related Environmental Changes and Resulting Effects: Other Ocean Uses 834
Table 13.3 Potential Project-VC Interactions and Associated Effects: Fisheries 835
Table 13.4 Potential Project-VC Interactions and Associated Effects: Other Ocean Uses 836
Table 13.5 Environmental Effects Assessment Summary: Fisheries 845
Table 13.6 Environmental Effects Assessment Summary: Other Ocean Uses 849
Table 14.1 Potential Project-Related VC Environmental Changes and Resulting Effects: Atmospheric Environment 855
Table 14.2 Potential Project-VC Interactions and Associated Effects: Atmospheric Environment 855
Table 14.3 Estimated Emissions from Semi-submersible MODU Operations 858
Table 14.4 Estimated Emissions from Drill Ship MODU Operations 859
Table 14.5 Estimated Emissions from Well Testing 860
Table 14.6 Estimated Emissions from Supply Vessels 861
Table 14.7 Estimated Emissions from Helicopter Operations 862
Table 14.8 Project Emissions of Criteria Air Compounds 863
Table 14.9 Global Warming Potentials 863
Table 14.10 GHG Emission Factors 864
Table 14.11 Project Total GHG Emissions by Activity 864
Table 14.12 GHG Emissions Comparison to Provincial, Federal and Global Targets 864
Table 14.13 Environmental Effects Assessment Summary: Atmospheric Environment 867
Table 15.1 Environmental Components Listed in the EIS Guidelines and their Consideration and Inclusion in the Cumulative Effects Assessment 872
Table 15.2 Other Projects and Activities Considered in the Cumulative Effects Assessment 874
Table 15.3 Other Projects and Activities Considered in the Cumulative Effects Assessment and their Potential Relevance to Each VC 880
Table 15.4 Marine Fish and Fish Habitat: Other Projects and Activities and their Environmental Effects 883
Table 15.5 Summary of Potential Cumulative Environmental Effects: Marine Fish and Fish Habitat 888

Table 15.6 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects 890
Table 15.7 Summary of Potential Cumulative Environmental Effects: Marine and Migratory Birds 894
Table 15.8 Marine Mammals and Sea Turtles: Other Projects and Activities and their Environmental Effects 896
Table 15.9 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles 900
Table 15.10 Special Areas: Other Projects and Activities and their Environmental Effects 902
Table 15.11 Summary of Potential Cumulative Environmental Effects: Special Areas 904
Table 15.12 Summary of Potential Cumulative Environmental Effects: Indigenous Peoples 907
Table 15.13 Fisheries and Other Ocean Uses: Other Projects and Activities and their Environmental Effects 910
Table 15.14 Summary of Potential Cumulative Environmental Effects: Fisheries and Other Ocean Uses 912
Table 15.15 Atmospheric Environment: Other Projects and Activities and their Environmental Effects 915
Table 15.16 Summary of Potential Cumulative Environmental Effects: Atmospheric Environment 916
Table 16.1 Exploration and Production Hydrocarbon Spill Information, Canada-NL Offshore Area (2012 – 2016) 944
Table 16.2 Calculated Oil Spill Probabilities and Frequencies 945
Table 16.3 Modelled Spill Scenarios for EL 1144 and EL 1150 947
Table 16.4 Selected Representative Deterministic Scenarios 948
Table 16.5 Thresholds Used to Define Areas and Volumes Exposed Above Levels of Concern 951
Table 16.6 Defined Ecological and Socioeconomic Thresholds for Oil Related Environmental Effects 953
Table 16.7 Model Input Data 954
Table 16.8 Physical Properties for the Two Oil Products Used in Modelling 954
Table 16.9 Fraction of the Whole Oil Comprised of Different Distillation Cuts for the Two Oil Products 955
Table 16.10 Predicted Areas Exceeding the Identified Thresholds for Surface Oil Thickness, Water Column Concentration, and Mass per Unit Area on Shorelines for the EL 1144 and EL 1150 Example Well Sites 957
Table 16.11 Shoreline Contamination Probabilities and Minimum Time for Oil Exposure Exceeding 1 g/m2 958
Table 16.12 EL 1144 Deepwater Jurassic Example Well Location, Seasonal SBM Footprint Statistics, Intermediate Phase 980
Table 16.13 EL 1144 Deepwater Jurassic Example Well Location, Seasonal SBM Footprint Statistics, Production Phase 980
Table 16.14 EL 1150 Shallow Water Cretaceous Example Well Location, Seasonal SBM Footprint Statistics 980
Table 16.15 Ecological and Socioeconomic Thresholds for Oil Related Environmental Effects 982
Table 16.16 VCs and Corresponding Relevant Modelling Results for Subsurface Blowouts 985
Table 16.17 Summary of Residual Accidental Event-Related Environmental Effects on Marine Fish and Fish Habitat 997
Table 16.18 Summary of Residual Accidental Event-Related Environmental Effects on Marine and Migratory Birds 1005

Table 16.19 Summary of Residual Accidental Event-Related Environmental Effects on Marine Mammals and Sea Turtles 1011
Table 16.20 Summary of Special Areas Overlapping with Modelled Uncontrolled Well Event in EL 1144 Example Well Site 1015
Table 16.21 Summary of Special Areas Overlapping with Modelled Uncontrolled Well Event in EL 1150 Example Well Site 1016
Table 16.22 Summary of Residual Accidental Event-Related Environmental Effects on Special Areas 1019
Table 16.23 Summary of Residual Accidental Event-Related Environmental Effects on Indigenous Peoples 1027
Table 16.24 Summary of Residual Accidental Event-Related Environmental Effects on Fisheries and Other Ocean Uses 1038
Table 17.1 Wind Speed Exceedance Values for Various Return Periods in the Project Area 1057
Table 17.2 Significant Wave Height Exceedance Values for Various Return Periods in the Project Area 1058
Table 18.1 Summary of Potential Project-VC Interactions and Associated Effects 1069
Table 18.2 Summary of Proposed Mitigation Measures and Their Relevance to each VC * 1072
Table 18.3 Summary of Predicted Residual Environmental Effects for Planned Project Activities 1079
Table 18.4 Summary of Predicted Residual Environmental Effects for Accidental Events 1081
Table 18.5 Other Potential Environmental Changes Linked to the Exercise of Power or Performance of Duty or Function by a Federal Authority 1093
Table 18.6 Summary of Predicted Residual Environmental Effects for Planned Project Activities, Possible Accidental Events, and Cumulative Effects 1095

LIST OF FIGURES

Page No.

Figure 1.1 Nexen Energy ULC Flemish Pass Exploration Drilling Project (2018-2028) 5
Figure 2.1 Project Area and Associated Exploration Licences 32
Figure 2.2 Project Area and Associated Exploration Licences (*Zoomed in Version*) 33
Figure 2.3 Examples of Semi-submersible (*Top*) and Drill Ship (*Bottom*) MODUs 37
Figure 2.4 Conceptual Diagram of a Typical Offshore Exploration / Appraisal Well 41
Figure 2.5 Potential Vessel and Aircraft Traffic Route 46
Figure 2.6 Project Schedule (Illustration of Single Well in Multi-Well Program) 48
Figure 4.1 Environmental Assessment Study Areas 108
Figure 5.1 Geological Overview (Bedrock) 118
Figure 5.2 Chronostratigraphy of Jeanne d'Arc Basin, Central Ridge and Flemish Pass Basin 120
Figure 5.3 Geomorphic Features 121
Figure 5.4 Seabed Features 122
Figure 5.5 Seismic Hazard Map 123
Figure 5.6 Earthquake Epicentres (1985-2017) and Seismotechtonic Setting 124
Figure 5.7 General Bathymetry and Ocean Current Circulation, Regional View 127
Figure 5.8 General Bathymetry, Project Area 128
Figure 5.9 Locations of the Wind and Wave MSC50 Node and Ocean Currents 130
Figure 5.10 Monthly Wind Roses, MSC50 Node M6012613 (1962–2015) 132
Figure 5.11 Annual Wind Rose, MSC50 Node M6012613 (1962–2015) 133

Figure 5.12 Air Temperature 134
Figure 5.13 Frequency of Occurrence (Percent) of Precipitation by Type 136
Figure 5.14 Frequency of Occurrence of Thunderstorm and Hail 136
Figure 5.15 Average Flash Density (Flashes per km^2 / year) for Eastern Canada (1999-2013)_ . 137
Figure 5.16 Frequency of Occurrence of Visibility 139
Figure 5.17 Monthly Wave Roses, MSC50 Node M6012613 (1962 – 2015) 142
Figure 5.18 Annual Wave Rose, MSC50 Node M6012613 (1962 – 2015) 143
Figure 5.19 Sackville Spur Region, VM ADCP Depth-Averaged Current Speed, July 2013 (Top: HUD2013021), July 2014 (Bottom: HUD2013021) 145
Figure 5.20 Flemish Pass Region, VM ADCP Depth-Averaged Current Speed, July 2013 (Top: HUD2013021), July 2014 (Bottom: HUD2013021) 146
Figure 5.21 Mean and Maximum Current Speed 147
Figure 5.22 Monthly, Near-Surface, Current Roses, EL 1144 Location 149
Figure 5.23 Monthly, Mid-Depth, Current Roses, EL 1144 Location 150
Figure 5.24 Monthly, Near-Bottom, Current Roses, EL 1144 Location 151
Figure 5.25 Monthly, Near-Surface, Current Roses, EL 1150 Location 152
Figure 5.26 Monthly, Mid-Depth, Current Roses, EL 1150 Location 153
Figure 5.27 Monthly, Near-Bottom, Current Roses, EL 1150 Location 154
Figure 5.28 Overview of pH for the Atlantic Ocean from the WOCE 159
Figure 5.29 Surface pH Data from Hibernia EEM Program (December 9, 2015) 159
Figure 5.30 Overview of the Project Area, Modelled Sites and Ambient Level Recording Stations 161
Figure 5.31 Project Area Locations Used for Sea Ice Characterization 165
Figure 5.32 Ice Concentrations from an Aerial Perspective 169
Figure 5.33 Frequency of Presence of Sea Ice, Week of Mar 12 171
Figure 5.34 Median of Ice Concentration When Ice Is Present, Week of Feb 26 171
Figure 5.35 Median of Predominant Ice Type When Ice Is Present, Week of Apr 23 172
Figure 5.36 Iceberg Sightings by Size Category (1985-2014), Project Area 173
Figure 5.37 Iceberg Sightings by Month (1985-2014), Project Area 174
Figure 5.38 Iceberg Sightings by Year (1985-2014), Project Area 174
Figure 5.39 Recorded Icebergs Sightings in 2015, Offshore Eastern Newfoundland 175
Figure 5.40 Projected Median (Left) and Maximum (Right) Annual Sustained Wind Speeds for the Mid-21st Century, Using a Six-Member Climate Model Ensemble Forced by the RCP 8.5 GHG Scenario 177
Figure 5.41 Change in the Annual Percentage of Days When Daily Max Wind Speed Is >51.9 km/h (fWsB7, Top Left), >62.0 km/h (fWsB8, Top Right), >75.0 km/h (fWsB9, Bottom Left), and >89.0 km/h (fWsB10, Bottom Right) 178
Figure 5.42 Changes In Mean Monthly Water Temperature From 1976-1995 to 1996-2015 at Approximately 5 m Depth, Based on ECMWF Reanalysis Data 180
Figure 5.43 Ensemble Agreement of Projected Near-Surface Ocean-Water Temperature Projections 181
Figure 5.44 Representative GCM Projection of 5 m Depth Ocean Water Temperature Change .. 182
Figure 5.45 Projected Median (Left) and Maximum (Right) Annual Wave Heights for the Mid-21st Century, Using a Six-Member Climate Model Ensemble Forced by the RCP 8.5 Greenhouse Gas Emissions Scenario 183
Figure 5.46 Change in the Annual Percentage of Days When Daily Max Significant Wave Height is >2.5 m (fHsRo, Left) and >6.0 m (fHsHi, Right) 184

Figure 6.1 Primary Depth Zones of the Project Area and Surrounding Marine Environments 193
Figure 6.2 Distribution of Chlorophyll Irradiance Measured from NASA Satellite Imagery of the North Atlantic, Winter to Fall 2016 199
Figure 6.3 Distribution of Northern Shrimp Based on Canadian RV Surveys (2008-2012) 207
Figure 6.4 Distribution of Northern Shrimp Based on Flemish Cap EU RV Surveys (2012-2015) 208
Figure 6.5 Coral Distribution Based on Canadian RV Surveys (2005-2015) 212
Figure 6.6 Sea Pen Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013) 215
Figure 6.7 Small Gorgonian Coral Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013) 216
Figure 6.8 Large Gorgonian Coral Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013) 217
Figure 6.9 Sponge Distribution Based on Canadian RV Surveys (2005-2015) 220
Figure 6.10 Sponge Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013) 222
Figure 6.11 Distribution of Lanternfish (Canadian RV Surveys, 2008-2012) 238
Figure 6.12 Distribution of Acadian and Deepwater Redfish Based on Canadian RV Surveys (2008-2012) 239
Figure 6.13 Distribution of Deepwater Redfish Based on Flemish Cap EU RV Surveys (2012-2015) 240
Figure 6.14 Distribution of Golden Redfish Based on Canadian RV Surveys (2008-2012) 241
Figure 6.15 Distribution of Golden Redfish Based on Flemish Cap EU RV Surveys (2012-2015) 242
Figure 6.16 Distribution of Acadian Redfish Based on Flemish Cap EU RV Surveys (2012-2015) 243
Figure 6.17 Distribution of Longnose Eel Based on Canadian RV Surveys (2008-2012) 244
Figure 6.18 Distribution of Roughhead Grenadier Based on Canadian RV Surveys (2008-2012) 245
Figure 6.19 Distribution of Roughhead Grenadier Based on the Flemish Cap EU RV Surveys (2012-2015) 246
Figure 6.20 Distribution of Roundnose Grenadier Based on Canadian RV Surveys (2008-2012) 247
Figure 6.21 Distribution of Common Grenadier Based on Canadian RV Surveys (2008-2012).... 248
Figure 6.22 Distribution of Blue Hake Based on Canadian RV Surveys (2008-2012) 249
Figure 6.23 Distribution of Greenland Halibut Based on Canadian RV Surveys (2008-2012) 250
Figure 6.24 Distribution of Greenland Halibut Based on the Flemish Cap EU RV Surveys, (2012-2015) 251
Figure 6.25 Distribution of Barracudina Based on Canadian RV Surveys (2008-2012)..... 252
Figure 6.26 Distribution of White Hake Based on Canadian RV Surveys (2008-2012) 253
Figure 6.27 Distribution of Atlantic Cod Based on Canadian RV Surveys (2008-2012)..... 254
Figure 6.28 Distribution of Atlantic Cod Based on Flemish Cap EU RV Surveys (2012-2015) 255
Figure 6.29 Spawning Periods and Locations for Key Species 256
Figure 6.30 Distribution of Northern (Broadhead) Wolffish Based on Canadian RV Surveys (2008-2012) 271
Figure 6.31 Distribution of Striped (Atlantic) Wolffish Based on Canadian RV Surveys (2008-2012) 272
Figure 6.32 Distribution of Spotted Wolffish Based on Canadian RV Surveys (2008-2012) 273
Figure 6.33 Generalized Migration Route of American Eels 274
Figure 6.34 Migration Tracks of Female White Sharks 275

Figure 6.35 Distribution of Thorny Skate Based on Canadian RV Surveys (2008-2012)..... 276
Figure 6.36 Atlantic Salmon: General Location of Currents and Summary Geographic Locations 277
Figure 6.37 Atlantic Salmon Research Vessel Catches in the Northwest Atlantic Ocean (1965-1985) 278
Figure 6.38 Numbers of Atlantic Salmon Tagged on and East of the Grand Banks (May 1979 and 1980), and Subsequent Recaptures in the Coastal Fishery and in Rivers..... 279
Figure 6.39 Atlantic Salmon Designatable Units (DU) in Eastern Canada 280
Figure 6.40 Overall Abundance of Organisms (Fish and Commercially Important Invertebrate Species) Inventoried from Canadian RV Trawl Survey Data (2008-2012)..... 282
Figure 6.41 Total Species Richness (Fish and Commercially Important Invertebrate Species) Inventoried from Canadian RV Trawl Survey Data (2008-2012) 283
Figure 6.42 Total Biomass (Fish and Commercially Important Invertebrate Species) Inventoried from Canadian RV Trawl Survey Data (2008-2012)..... 284
Figure 6.43 Summary of Seasonal Presence of Marine-Associated Birds 301
Figure 6.44 Seabird Colony Locations in Eastern Newfoundland 307
Figure 6.45 Baleen Whale Sightings off Eastern Newfoundland..... 312
Figure 6.46 Dolphin and Porpoise Sightings off Eastern Newfoundland 313
Figure 6.47 Other Toothed Whale Sightings off Eastern Newfoundland 314
Figure 6.48 Pinniped Sightings off Eastern Newfoundland 315
Figure 6.49 Sea Turtle Sightings off Eastern Newfoundland..... 316
Figure 6.50 Bioregion and Large Ocean Management Area..... 323
Figure 6.51 EBSAs, MPAs. Marine Refuges and Federal Fisheries Closure Areas 326
Figure 6.52 Preliminary RMAs and MBSs..... 331
Figure 6.53 Coastal National Parks and National Historic Sites..... 334
Figure 6.54 Provincial Protected and Special Areas 336
Figure 6.55 Vulnerable Marine Ecosystem Areas..... 341
Figure 6.56 NAFO Fisheries Closure Areas..... 346
Figure 6.57 Important Bird Areas and UNESCO World Heritage Sites 350
Figure 7.1 Local Areas in Eastern Newfoundland..... 378
Figure 7.2 Economic Zones in Eastern Newfoundland 379
Figure 7.3 Police Reported Incidents in RNC Jurisdictions..... 390
Figure 7.4 Select Police Reported Incidents on the Northeast Avalon 390
Figure 7.5 NAFO Convention Area, NRA and Divisions..... 393
Figure 7.6 NAFO Unit Areas..... 394
Figure 7.7 All Species: Project Area UAs and Adjacent UAs, Quantity of Harvest by Year, 1985-2009 396
Figure 7.8 Groundfish vs Other Species: Project Area UAs Quantity of Harvest by Year, 1985-2009 397
Figure 7.9 Groundfish vs Other Species, Adjacent UAs Quantity of Harvest by Year, 1985-2009 397
Figure 7.10 Species Composition by Quantity of Harvest, Project Area UAs 1985 398
Figure 7.11 Species Composition by Quantity of Harvest, Project Area UAs 2009 398
Figure 7.12 Species Composition of Harvest by Quantity, Adjacent UAs 1985..... 399
Figure 7.13 Species Composition of Harvest by Quantity, Adjacent UAs 2009..... 399
Figure 7.14 Species Types by Quantity of Harvest, Project Area Unit Areas 2010-2015 Average 402
Figure 7.15 Species Types by Quantity of Harvest, Adjacent Unit Areas 2010-2015 Average 402
Figure 7.16 All Species Quantity by Year, Project Area UAs and Adjacent UAs 2010-2015 403

Figure 7.17 All Species Value by Year, Project Area UAs and Adjacent UAs 2010-2015 404
Figure 7.18 Relative Quantity of Domestic Harvest by Unit Area, Adjacent Unit Areas 2010-2015 405
Figure 7.19 Relative Value of Domestic Harvest by Unit Area, Adjacent Unit Areas 2010-2015 .. 405
Figure 7.20 Domestic Commercial Harvesting Locations, All Species, 2010-2015 407
Figure 7.21 Domestic Commercial Harvesting Intensity by Locations, All Species, 2010-2015.... 408
Figure 7.22 Fixed Gear Harvesting Locations, 2010-2015..... 411
Figure 7.23 Mobile Gear Harvesting Locations, 2010-2015..... 412
Figure 7.24 Fixed Gear Harvesting Locations, by Quarter, 2010-2015 413
Figure 7.25 Mobile Gear Harvesting Locations, by Quarter, 2010-2015 414
Figure 7.26 All Species, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average..... 416
Figure 7.27 All Species, Project Area UAs and Adjacent UAs Value of Harvest by Month, 2010-2015 Average..... 416
Figure 7.28 All Species Harvesting Locations, January 2010 – 2015..... 417
Figure 7.29 All Species Harvesting Locations, February 2010 – 2015..... 418
Figure 7.30 All Species Harvesting Locations, March 2010 – 2015 419
Figure 7.31 All Species Harvesting Locations, April 2010 – 2015..... 420
Figure 7.32 All Species Harvesting Locations, May 2010 – 2015 421
Figure 7.33 All Species Harvesting Locations, June 2010 – 2015 422
Figure 7.34 All Species Harvesting Locations, July 2010 – 2015..... 423
Figure 7.35 All Species Harvesting Locations, August 2010 – 2015 424
Figure 7.36 All Species Harvesting Locations, September 2010 – 2015..... 425
Figure 7.37 All Species Harvesting Locations, October 2010 – 2015..... 426
Figure 7.38 All Species Harvesting Locations, November 2010 – 2015..... 427
Figure 7.39 All Species Harvesting Locations, December 2010 – 2015..... 428
Figure 7.40 Commercial Harvesting Intensity by Locations, All Species, by Quarter 2010-2015.. 429
Figure 7.41 Snow/Queen Crab, Project Area UAs and Adjacent UAs Quantity of Harvest by Year, 2010-2015 432
Figure 7.42 Snow/Queen Crab, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average..... 432
Figure 7.43 Harvesting Locations Snow Crab, All Months 2010-2015 433
Figure 7.44 Northern Shrimp, Project Area UAs and Adjacent UAs Quantity of Harvest by Year, 2010-2015 435
Figure 7.45 Northern Shrimp, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average..... 435
Figure 7.46 Harvesting Locations Northern Shrimp, All Months 2010-2015..... 436
Figure 7.47 Groundfish, Project Area UAs and Adjacent UAs Quantity of Harvest by Year, 2010-2015 438
Figure 7.48 Groundfish, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average..... 438
Figure 7.49 Key Groundfish Species, Adjacent Unit Areas Quantity of Harvest by Year, 2010-2015 439
Figure 7.50 Harvesting Locations All Groundfish Species, 2010-2015..... 440
Figure 7.51 Harvesting Locations Redfish, 2010-2015 442
Figure 7.52 Harvesting Locations Turbot/Greenland Halibut, 2010-2015..... 443
Figure 7.53 Harvesting Locations Atlantic Cod, 2010-2015 445

Figure 7.54 NAFO Divisions 3KLMNO Quantity of Domestic Harvest by Year, 2010-2015 449
Figure 7.55 NAFO Divisions 3KLMNO Value of Domestic Harvest by Year, 2010-2015 449
Figure 7.56 NAFO Divisions 3KLMNO Relative Quantity of Domestic Harvest by Division, 2010-2015 451
Figure 7.57 NAFO Division 3KLMN Relative Value of Domestic Harvest by Division 2010-2015 451
Figure 7.58 NAFO Divisions 3KLMNO Quantity of Domestic Harvest by Month, 2010-2015 Average 453
Figure 7.59 NAFO Divisions 3KLMNO Value of Domestic Harvest by Month, 2010-2015 Average 453
Figure 7.60 Canadian and Foreign NAFO Divisions 3L and 3M Quantity of Harvest by Year, 2007 - 2016 456
Figure 7.61 NAFO NRA Fisheries “Footprint” 458
Figure 7.62 Average Fishing Effort in 5th Percentile Categories using Gridded VMS Data (2008-2012) 459
Figure 7.63 NAFO Divisions 3KLMNO Quantity of Canadian and Foreign Harvest by Year, 2007 – 2016 460
Figure 7.64 NAFO Divisions 3KLMNO Relative Quantity of Foreign Harvest by Division, 2007 – 2016 463
Figure 7.65 Location of DFO Research Vessel Survey Transects 465
Figure 7.66 Locations of Industry - DFO Survey Stations 467
Figure 7.67 Seal Harvesting Area 469
Figure 7.68 Aquaculture Sites on the Island of Newfoundland 470
Figure 7.69 Marine Shipping and Transportation in Eastern Newfoundland 472
Figure 7.70 Marine Shipping Activity at St. John’s Harbour 473
Figure 7.71 Small Craft Harbours in Eastern Newfoundland 475
Figure 7.72 Marine Traffic Management in Eastern Newfoundland 477
Figure 7.73 Petroleum Exploration and Production in Eastern Newfoundland 480
Figure 7.74 Legacy Sites, Explosive Dumpsites and Shipwrecks of Concern off Eastern Newfoundland 483
Figure 7.75 Federal Lands in Eastern Newfoundland 485
Figure 7.76 Subsea Cables in Eastern Newfoundland 487
Figure 7.77 Select Coastal and Marine-Based Tourism Sites in Eastern Newfoundland 489
Figure 7.78 Coastal Natural and Cultural Heritage Sites in Eastern Newfoundland 491
Figure 7.79 Waterfowl and Seabird Hunting Areas off Eastern Newfoundland 493
Figure 7.80 Indigenous Communities in Eastern Canada 496
Figure 7.81 Indigenous Communities in Labrador 499
Figure 7.82 Indigenous Communities in Newfoundland 500
Figure 7.83 Labrador Inuit Land Claims Area 502
Figure 7.84 Labrador Innu Land Claims Area 508
Figure 7.85 NunatuKavut Community Council Land Claims Area 513
Figure 7.86 Indigenous Communities in Nova Scotia 521
Figure 7.87 Indigenous Communities in New Brunswick 546
Figure 7.88 Indigenous Communities in Prince Edward Island 573
Figure 7.89 Indigenous Communities in Québec 578
Figure 8.1 Marine Fish and Fish Habitat: Environmental Assessment Study Areas 615
Figure 8.2 Example Wellsite Locations Used in EIS Modelling 635

Figure 8.3 Total Cuttings Material Above the 1.5 mm and 6.5 mm PNET: EL 1144 Deepwater Jurassic Example Well..... 638
Figure 8.4 Total Cuttings Material above the 1.5 mm and 6.5 mm PNET: EL 1150 Shallow Water Cretaceous Example Well 641
Figure 9.1 Marine and Migratory Birds: Environmental Assessment Study Areas..... 690
Figure 10.1 Marine Mammals and Sea Turtles: Environmental Assessment Study Areas 726
Figure 11.1 Special Areas: Environmental Assessment Study Areas 765
Figure 11.2 Overview of Special Areas that Overlap with the Project Area, LSA and Potential Traffic Route..... 777
Figure 12.1 Indigenous Peoples: Environmental Assessment Study Areas 784
Figure 12.2 Domestic Commercial Harvesting Locations: Swordfish (2010-2015)..... 815
Figure 13.1 Fisheries and Other Ocean Uses: Environmental Assessment Study Areas..... 830
Figure 14.1 Atmospheric Environment: Environmental Assessment Study Areas..... 853
Figure 15.1 Other Projects and Activities Considered in the Cumulative Effects Assessment..... 878
Figure 16.1 Nexen PSM Framework..... 922
Figure 16.2 Bow Tie Analysis 923
Figure 16.3 Example Capping Stack 929
Figure 16.4 Number of Spill Incidents Canada- NL Offshore Area (1997-2017)..... 939
Figure 16.5 Total Spill Volume, Canada-NL Offshore Area (1997-2017) 940
Figure 16.6 Spills by Year by Type, Canada-NL Offshore Area (1997-2017, Spills > 1 L) 940
Figure 16.7 Spill Frequency by Type, Exploration Drilling - 1997-2016 (% of Incidents) 941
Figure 16.8 Spill Volume by Type, Exploration Drilling - 1997-2016 (% of Volume) 942
Figure 16.9 Spill Frequency by Type, Development Drilling & Production - 1997-2016 (% of Incidents) 942
Figure 16.10 Spill Volume by Type, Development Drilling & Production - 1997-2016 (% of Volume)..... 943
Figure 16.11 Summer Probability of Average Surface Oil Thickness >0.04 µm (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Pass EL 1144 Well Site..... 959
Figure 16.12 Summer Probability of Dissolved Hydrocarbon Concentrations >1 µg/L at Some Depth in the Water Column (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Pass EL 1144 Example Well Site..... 960
Figure 16.13 Summer Probability of Shoreline Contact >1 G/M² (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Pass EL 1144 Example Well Site 961
Figure 16.14 Summer Probability of Average Surface Oil Thickness >0.04 µm (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at The Flemish Cap EL 1150 Example Well Site 962
Figure 16.15 Summer Probability of Dissolved Hydrocarbon Concentrations >1 µg/L at Some Depth in the Water Column (Top) And Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Cap EL 1150 Example Well Site 963
Figure 16.16 Summer Probability of Shoreline Contact >1 G/M² (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Cap EL 1150 Example Well Site 964
Figure 16.17 Winter Probability of Shoreline Contact >1 G/M² (Top) and Minimum Time to Threshold

Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Cap EL 1150 Example Well Site 965
Figure 16.18 Representative Scenario for 95th Percentile Average Surface Oil Thickness Resulting from A 30-Day Subsurface Blowout at EL 1144 (Top) and the EL 1150 (Bottom) Example Well Sites. 968
Figure 16.19 Maximum Total Hydrocarbon Concentration (THC) at Any Depth in the Water Column for the 95th Percentile Water Column Contamination Case Resulting from a 30-Day Subsurface Blowout at EL 1144 (Top) and EL 1150 (Bottom) Example Well Sites. .. 970
Figure 16.20 THC on the Shore and Sediment for the 99th Percentile Contact with Shoreline Case Resulting from a 30-Day Subsurface Blowout at EL 1150 Example Well Sites 971
Figure 16.21 Mass Balance Plots of the EL 1144 Example Well Site Release of Marine Diesel From Batch Spills of 100 L (Top) and 1,000 L (Bottom) 973
Figure 16.22 Surface Oil Thickness Resulting from the EL 1144 Example Well Site Release of Marine Diesel from Batch Spills of 100 L (Top) and 1,000 L (Bottom)..... 974
Figure 16.23 Mass Balance Plots of the VCL Release Site of Marine Diesel from the Vessel Collision Release of 750,000 L 975
Figure 16.24 Surface Oil Thickness Resulting from the VCL Release of Marine Diesel from the Vessel Collision Release of 750,000 L 976
Figure 16.25 Model Results (Water Column Oil Concentration; Ecological Threshold) for Modelled Uncontrolled Well Event at EL 1144 Example Well Site in Relation to Special Areas..... 1017
Figure 16.26 Model Results (Water Column Oil Concentration; Ecological Threshold) for Modelled Uncontrolled Well Event at EL 1150 Example Well Site in Relation to Special Areas..... 1018
Figure 16.27 Model Results for Modelled Uncontrolled Well Event at EL 1144 Example Well Site in Relation to NAFO Subdivisions and Fishing Intensity 1036
Figure 16.28 Model Results for Modelled Uncontrolled Well Event at EL 1150 Example Well Site in Relation to NAFO Subdivisions and Fishing Intensity 1037

LIST OF APPENDICES

Appendix A Key Personnel Responsible for EIS Preparation

Appendix B Species Names

Appendix C Additional Marine and Migratory Birds Information

Appendix D Drill Cuttings Modelling (Amec Foster Wheeler 2017)

Appendix E Underwater Sound Propagation Assessment (JASCO 2017)

Appendix F Spill Probability Assessment (SL Ross 2017)

Appendix G Oil Spill Modelling (RPS 2017)

Appendix H SBM Accidental Spill Modelling (Amec Foster Wheeler 2017)

LIST OF ACRONYMS AND ABBREVIATIONS

AAROM	Aquatic Resource and Oceans Management
ACSS	Atlantic Canada Shorebird Survey
ADCP	Acoustic Doppler Current Profiler
ADW	Approval to Drill a Well
AESL	Department of Advanced Education, Skills and Labor
AFS	Aboriginal Fisheries Strategy
AICFI	Atlantic Integrated Commercial Fisheries Initiative
AIP	Agreement in Principle
AL	Aliphatic
ANSMC	Assembly of Nova Scotia Mi'kmaq Chiefs
AOI	Area of Interest
APC	Atlantic Policy Congress
AR	Aromatic
BHA	Bottom Hole Assembly
BIO	Bedford Institute of Oceanography
BLM	Bureau of Land Management
BML	Below Mud Line
BOP	Blowout Preventers
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CAAQS	Canadian Ambient Air Quality Standards
CAPP	Canadian Association of Prawn Producers
CBC	Canadian Broadcasting Corporation
CCG	Canadian Coast Guard
CCPS	Center for Chemical Process Safety
CEAA	Canadian Environmental Assessment Agency
CEAA 2012	Canadian Environmental Assessment Act, 2012
CECOM	Canadian East Coast Ocean Model
CEPA	Canadian Environmental Protection Act
CETAP	Cetacean and Turtle Assessment Program
CFA	Crab Fishing Area
CIS	Canadian Ice Service
CMM	Confederacy of Mainland Mi'kmaq
CNA	College of the North Atlantic
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNOOC	China National Offshore Oil Corporation
COSEWIC	Committee on The Status of Endangered Wildlife in Canada
CPA	Canada Port Authorities
CPAWS	Canadian Parks and Wilderness Society
CPUE	Catch-Per-Unit-Effort
CSA	Canada Shipping Act
CTD	Conductivity, Temperature and Dissolved Oxygen

CWS	Canadian Wildlife Service
dB	Decibels
DFO	Fisheries and Oceans Canada
DGNSR	Director General Naval Strategic Readiness
DND	Department of National Defense
DP	Dynamic Positioning
DU	Designatable Units
DWH	Deepwater Horizon Spill
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
ECCC	Environment and Climate Change Canada
ECMWF	European Center for Medium Range Weather Forecasting
ECRC	Eastern Canada Response Corporation
ECSAS	Eastern Canadian Seabirds at Sea
EEM	Environmental Effects Monitoring
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EL	Exploration Licenses
EOC	Emergency Operations Centre
EPP	Environmental Protection Plan
ERP	Emergency Response Plan
ESRF	Environmental Studies Research Fund
EU	European Union
FAO	Food and Agriculture Organization
FCA	Fishery Closure Area
FFAW-Unifor	Fish, Food and Allied Workers Union
FFT	Fast Fourier Transforms
FLO	Fisheries Liaison Officer
FNI	Federation of Newfoundland Indians
FPSO	Floating Production, Storage and Offloading
FSC	Food, Social and Ceremonial
GBS	Gravity Based Structure
GCM	Global Climate Model
GDP	Gross Domestic Product
GEAC	Groundfish Enterprise Allocation Council
GHGRP	Greenhouse Gas Emission Reporting Program
GWP	Global Warming Potential
HIRA	Hazard Identification and Risk Analysis
HMDC	Hibernia Management and Development Company Ltd.
HSE	Health, Safety, Environment
HSE&A	Health, Safety, Environment and Assurance
HSE&SR	Health, Safety, Environment and Social Responsibility
HVGB	Happy Valley-Goose Bay
Hz	Hertz

IBA	Important Bird Areas
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
ICS	Incident Command System
IIP	International Ice Patrol
IMO	International Maritime Organization
INAC	Indigenous and Northern Affairs Canada
IO	Internal Olefins
IOC	Iron Ore Company of Canada
IUCN	International Union for the Conservation of Nature
KMKNO	Kwilmu’kw Maw-Klusuaqn Negotiation Office
LAO	Linear Alpha Olephins
LFA	Lobster Fishing Area
LIA	Labrador Inuit Association
LIL	Labrador Inuit Lands
LILCA	Labrador Inuit Land Claims Agreement
LISA	Labrador Inuit Settlement Area
LMW	Lower Molecular Weights
LRMP	Lower Marine Riser Package
LSA	Local Study Area
LWD	Logging While Drilling
MAE	Department of Municipal Affairs and Environment
MAH	Major Accident Hazard
MAMKA	Mi'kmaq Alsumk Mowimsikik Koqoey Association
MARLANT	Maritime Forces Atlantic
MARPOL	International Convention for the Prevention of Pollution from Ships
MBCA	Migratory Birds Convention Act
MBS	Migratory Bird Sanctuaries
MCPEI	Mi’kmaq Confederacy of Prince Edward Island
MCTS	Marine Communications and Traffic Services
MFN	Miawpukek First Nation
MICT	Regroupement Mamit Innuat Tribal Council
MMO	Marine Mammals Observer
MMS	Mi’gmawei Mawiomi Secretariat
MODU	Mobile Offshore Drilling Unit
MPA	Marine Protected Area
MPMO	Major Projects Management Office
MRI	Marshall Response Initiative
MSW	Multi Sea Winter
MTI	Mi’gmawe’ Tplu’taqn Incorporated
MWA	Marine National Wildlife Area
MWD	Measurements While Drilling
NAFO	North Atlantic Fisheries Organization
NAO	North Atlantic Oscillation
NAS	National Airports System

NASCO	North Atlantic Salmon Conservation Organization
NATO	North Atlantic Treaty Organization
NCC	NunatuKavut Community Council
NEBA	Net Environmental Benefits Analysis
NHS	National Historic Sites
NM	Nautical Mile
NMCA	National Marine Conservation Areas
NMS	Nexen Management System
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NOIA	Newfoundland and Labrador Oil and Gas Industries Association
NORAD	North American Aerospace Defense Command
NP	Newfoundland Power
NPRI	National Pollutant Release Inventory
NRA	NAFO Regulatory Area
NRCan	Natural Resources Canada
NRC-PERD	National Research Council
NSMDC	North Shore Micmac District Council
NSRF	Northern Shrimp Research Fund
NWA	National Wildlife Area
OA	Operations Authorization
OBIS	Ocean Biogeographic Information System
OCI	Ocean Choice International
OCNS	Offshore Chemical Notification System
OCS	Outer Continental Shelf
OCSG	Offshore Chemical Selection Guidelines
ODI	Ocean Data Inventory
OIM	Offshore Installation Manager
OL	Operating License
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OSRL	Oil Spill Response Limited
OWTG	Offshore Waste Treatment Guidelines
PAH	Polycyclic Aromatic Hydrocarbons
PBGB LOMA	Placentia Bay Grand Banks Large Ocean Management Area
PIROP	Programme Intégré des Recherches Sur Les Oiseaux Pélagiques
PLONOR	Pose Little or No Risk to the Environment
PM_{10}	Particulate Matter Less Than 10 Microns in Diameter
$PM_{2.5}$	Particulate Matter Less Than 2.5 Microns in Diameter
PNET	Predicted No Effects Threshold
PPFG	Pore Pressure Fracture Gradient
PSM	Process Safety Management
PTS	Permanent Threshold Shifts
RCMP	Royal Mounted Canadian Police

RCN	Royal Canadian Navy
RCP	Representative Concentration Pathway
RFB	Regional Fishery Body
RMA	Representative Marine Area
RNC	Royal Newfoundland Constabulary
ROV	Remotely Operated Vehicle
RSA	Regional Study Area
RV	Research Vessel
SAR	Species at Risk
SARA	Species at Risk Act
SBM	Synthetic Based Mud
SCC	Supreme Court of Canada
SDL	Significant Discovery License
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SGRMM	Société De Gestion des Rivières Manitou Et Mingan
SO_2	Sulphur Dioxide
SOCC	Species of Conservative Concern
SOCP	Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in The Marine Environment
SPANS	Spatial Analysis System
SPE	Society of Petroleum Engineers
SPL	Sound Pressure Level
SPOC	Single Point of Contact
SR	Search and Rescue
SSB	Spawning Stock Biomass
SST	Sea Surface Temperature
TAC	Total Allowable Catch
TC	Transport Canada
THC	Total Hydrocarbon Concentration
TLH	Trans Labrador Highway
TPH	Total Petroleum Hydrocarbons
TPM	Total Particulate Matter
TSS	Total Suspended Solids
TTS	Temporary Threshold Shifts
TUS	Traditional Use Study
UA	Unit Area
UDG	Ullnooweg Development Group
UINR	Unama'ki Institute of Natural Resources
UN	United Nations
UNCLOS	United Nations Convention of the Law of the Seas
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
UNSI	Union of Nova Scotia Indians

UXO	Unexploded Ordnance
VC	Valued Component
VCL	Vessel Collision Location
VDL	Variable Deck Load
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring Systems
VOC	Volatile Organic Compounds
VSP	Vertical Seismic Profiling
WBM	Water Based Mud
WBR	World Biosphere Reserves
WDP	Well Delivery Process
WGESA	Working Group of Ecosystem Science Assessment
WHS	World Heritage Site
WHSRN	Western Hemisphere Shorebird Reserve Network
WNNB	Wolastoqey Nation of New Brunswick
WOCE	World Ocean Circulation Experiment
WWF	World Wildlife Fund

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1 INTRODUCTION

Nexen Energy ULC, a wholly-owned subsidiary of CNOOC Limited (Nexen), is planning to conduct a program of petroleum exploration drilling and associated activities in the eastern portion of the Canada-Newfoundland and Labrador Offshore Area over the period 2018 to 2028 (hereinafter also referred to as the Project). The Project Area includes two Exploration Licences (ELs 1144 and 1150) in the Flemish Pass region for which Nexen is currently the Operator[1] and sole interest holder and which have not yet been subject to exploration drilling activity to date pursuant to these licences, as well as a 20 km buffer area surrounding the two licences to accommodate the location and extent of ancillary activities that may be carried out in support of such drilling activities. The Project will include exploration drilling within these ELs, possible appraisal (delineation) drilling in the event of a hydrocarbon discovery, vertical seismic profiling (VSP), well testing, eventual well abandonment or suspension procedures, and associated supply and service activities.

The Project requires review and approval pursuant to the requirements of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). It has been determined to constitute a "designated project" under the associated *Regulations Designating Physical Activities*, given that it includes the drilling, testing and abandonment of offshore exploratory wells in the first drilling program in an area set out in one or more ELs issued in accordance with the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Act.* The environmental assessment (EA) review of the Project under CEAA 2012 commenced in April 2017 with Nexen's submission of a Project Description and associated Summary Documents to the Canadian Environmental Assessment Agency (the Agency), which were subsequently made available for government and public review. Following that review period, on June 9, 2017, the Agency determined that a federal EA was required for the Project and issued the associated Notices of EA Determination and EA Commencement, as well as Draft Environmental Impact Statement (EIS) Guidelines, which were subsequently finalized and issued to Nexen on July 25, 2017.

This EIS has been planned, prepared and submitted by Nexen in accordance with the requirements of CEAA 2012 as well as the Project-specific EIS Guidelines (July 2017) and other generic EA guidance documents issued by the Agency. It has also been designed and completed to address the EA requirements of the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) under the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Act* and the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* (the Accord Acts).

As an introduction to the EIS, this chapter identifies the Proponent, provides a general overview of the Project, outlines the regulatory contexts for the Project, and describes the purpose of the EIS and the overall organization of the document.

1.1 Identification and Overview of the Proponent

Nexen is an upstream oil and gas company that is responsible for managing its energy resources in Canada and providing management services and oversight to its affiliates including in the UK North

[1] Subject to regulatory approvals, Nexen or any future partners may serve as Operator during this Project. The Operator will honour all commitments, mitigations and regulatory requirements for any Project activities that are the subject of this EIS, including any terms and conditions of EA approval

Sea, offshore West Africa, and the United States. Nexen manages three principal lines of businesses: 1) Conventional oil and gas, 2) Oil sands, and 3) Shale gas/oil. Although Nexen manages onshore production in several areas around the world, the largest component of the conventional business it manages occurs offshore, with approximately half of the production coming from offshore facilities in the UK North Sea, West Africa, and the Gulf of Mexico. The company also has significant assets in Canada's oil sands industry, and produces shale gas in northeastern British Columbia in addition to managing working interests in several shale projects in the United States. Further information on Nexen can be found at *www.nexencnoocltd.com*

1.1.1 Nexen's Offshore Experience

Nexen is one of the largest oil producers in the UK North Sea, and is the Operator of the Buzzard, Golden Eagle and Scott developments. Buzzard is the largest UK North Sea oil discovery in the past two decades, and Golden Eagle was the second largest oil discovery in the UK North Sea since the Buzzard discovery in 2001. Recent exploration projects in the region include the UK West Shetlands, and the acquisition of four licenses in the Irish Atlantic Margin.

Nexen also has working interest in the Usan field in offshore West Africa, as well as the deepwater Stampede & Appomattox development and Norphlet plays in the Gulf of Mexico. Stampede is located 258 kilometers off the Louisiana coast in approximately 1,000 m of water, and Appomattax is located approximately 129 kilometers off the coast of Louisiana in approximately 2,000 m of water. Nexen also has a partnership in the Stabroek License in offshore Guyana, and announced the world's largest oil discovery in 2015, located 193 kilometers offshore in 1,743 m of water.

Nexen has extensive experience drilling offshore and deepwater offshore wells in many regions around the world, as both an operator and a partner. As an operator, Nexen has drilled in the following regions over the past 15 years: UK North Sea Shelf, deepwater UK West of Shetlands, Norwegian North Sea Shelf, deepwater and shelf West Africa, deepwater US Gulf of Mexico and the US Gulf of Mexico Shelf.

1.1.2 Health, Safety, Environment and Assurance

Health, safety and environmental protection are core values at Nexen and the success of every activity undertaken by Nexen is measured on the ability to execute work safely each and every day. Nexen's business objectives are to operate safely and responsibly without causing harm to employees, contractors, joint venture partners or the communities in which Nexen operates and to minimize the environmental impacts of Nexen's activities. Nexen is committed to promoting a culture of Safety First; striving for best-in-class health, safety and environmental performance.

The Nexen Health, Safety, Environment & Assurance (HSE&A) Policy commits to the following:

- Regulatory requirements, of the jurisdictions in which we operate, shall be met or exceeded to protect employees, contractors, the environment and communities' health, safety, security and well-being.

- An HSE&A focused culture shall be promoted, sustained and continuously improved across Nexen.

- Formal processes for identifying hazards, managing risks and ensuring compliance shall be developed, documented and implemented.

- Incidents and any departures from planned arrangements shall be promptly and effectively investigated, appropriate actions taken and findings shared to prevent recurrence.

- HSE&A policies, standards, processes and procedural aids shall be met or exceeded by all employees, contractors and their subcontractors undertaking work.

Nexen has developed an Integrated Management System (Nexen Management System, NMS) that consists of 13 fundamental Elements to enable and assure leading performance in all business units within the organization:

1) Leadership
2) Full Asset Lifecycle Operations
3) Business Development
4) Risk Management
5) Organization & People
6) HSE&A
7) Social Responsibility
8) Financial Management
9) Supply Chain Management
10) Information Management
11) Legal
12) Continuous Improvement
13) Change Management

The Atlantic Canada region's management system will incorporate all of the fundamental elements of the NMS, and will include (but will not be limited to) specific regional procedures for environmental management, ice management, oil spill response, emergency response and communications.

As noted above, environmental protection is a core value at Nexen and the company is committed to minimizing the environmental impacts of its activities. Nexen uses a variety of tools that will help to ensure that the environmental commitments and mitigations identified for a project are communicated and followed during its operations. Notwithstanding its internal processes and requirements for managing, monitoring and reporting on its environmental performance, Nexen will also adhere to all of the applicable legislative and regulatory requirements that pertain to this Project. This includes any terms and conditions imposed as conditions of any associated EA review and approval for the Project, and will monitor and report on these in accordance with applicable regulatory procedures or other relevant requirements.

1.1.3 Nexen Contacts

Nexen operates an office in St. John's NL, where Nexen's offshore Newfoundland and Labrador activities are managed.

The principal Nexen contacts concerning this Project and its EA review are as follows:

Regional Contact:

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1.2 Project Location and Overview

This section provides a brief overview of the Project, including its location, planned components and activities and its environmental setting and context, as initial background for the EIS. Further details on each of these items are provided in subsequent chapters.

1.2.1 Project Location

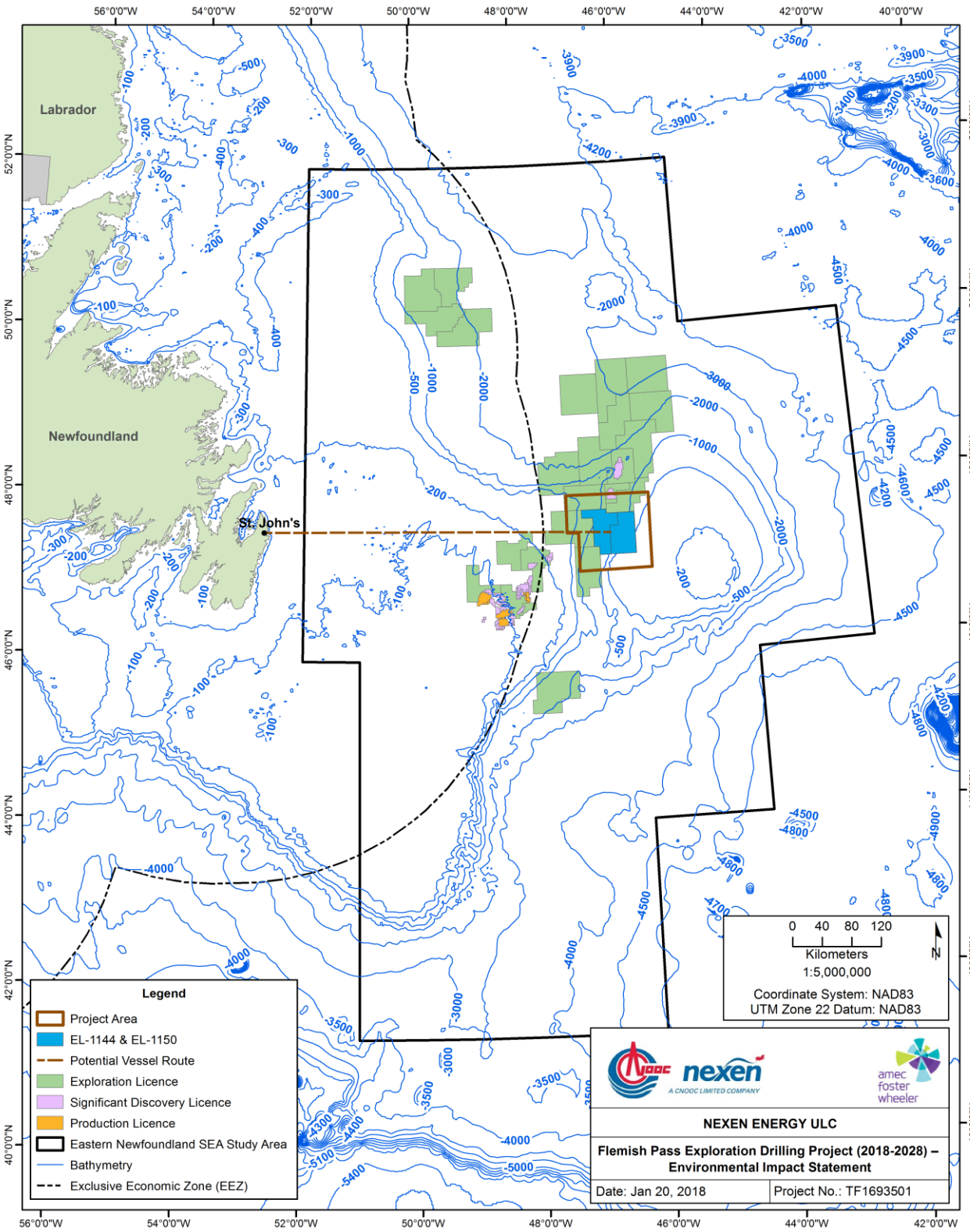
The Project will take place in a marine area offshore Eastern Newfoundland (Figure 1.1). The Project Area itself covers approximately 10,634 km^2, the western edge of which is over 400 km from the Island of Newfoundland.

The Project Area incorporates ELs 1144 and 1150 in the Flemish Pass region where Nexen is proposing to conduct exploration drilling activities within the term of these current licences and for which Nexen is currently the sole interest holder and Operator (Table 1.1).

Table 1.1 Nexen Exploration Licences Within the Project Area

Licence Number	Interest Holder (% ownership)	Licence Area (hectares / km^2)	Expiry: Period I Period II	Drilling Activity Under Current EL
EL 1144	Nexen (100%)	163,008 ha / 1,630.08 km^2	January 15, 2022 January 15, 2025	No drilling has occurred
EL 1150	Nexen (100%)	169,578 ha 1,695.78 km^2	January 15, 2023 January 15, 2026	No drilling has occurred

Figure 1.1 Nexen Energy ULC Flemish Pass Exploration Drilling Project (2018-2028)



The Project Area includes a 20 km buffer area surrounding the two licences to (conservatively) accommodate the location and extent of ancillary activities that may be carried out in support of such drilling activities. These may include, for example, any Project components or activities that are required to extend beyond the immediate boundaries of the ELs themselves, such as the required temporary presence and movement of the mobile offshore drilling unit(s) (MODUs) or support vessels and aircraft during initial mobilization and set up or eventual demobilization from a drill site, as well as any required non-drilling activities that could conceivably extend to outside the licence boundary. All drilling operations carried out as part of the scope of this Project will, however, be conducted within the defined boundaries of EL 1144 and EL 1150. The EIS also considers and assesses an identified potential supply vessel and aircraft traffic route from Eastern Newfoundland to the Project Area.

As illustrated in Figure 1.1, ELs 1144 and 1150 and the surrounding Project Area are located off Eastern Newfoundland, outside Canada's 200 nautical mile Exclusive Economic Zone (EEZ) on the outer continental shelf. As also illustrated in the figure, they are also located entirely within the Study Area for the Eastern Newfoundland Strategic Environmental Assessment (SEA) completed for the C-NLOPB in August 2014 (Amec 2014).

1.2.2 Key Project Components and Activities

The objective of the Project is to determine the potential presence of hydrocarbons within the ELs offshore Eastern Newfoundland that are currently held by Nexen. The key components and activities of the Project are: exploration drilling within the various ELs identified above; possible appraisal (delineation) drilling in the event of a hydrocarbon discovery; VSP; well testing; eventual well abandonment or suspension procedures; and associated supply and service activities.

The scope of the Project may involve the drilling of up to 10 wells (exploration or appraisal) over its planned temporal duration. Specific wellsite types and locations will be selected as Project planning and design activities move forward. Wells may be drilled using either harsh environment semi-submersible or drill ship MODUs, and it is possible that at times there could be two MODUs involved in Project-related drilling activities in different parts of the Project Area simultaneously. VSP surveys may also be conducted following completion of drilling to obtain accurate time-to-depth ties to correlate seismic data to well depth. If there is an indication of commercial hydrocarbons found during the exploration drilling program, a well flow test may be conducted to sample and identify formation fluids (which may contain hydrocarbons and/or water) and to measure produced flow rates. Once completed, well abandonment or suspension activities will be undertaken. Wells will be monitored and inspected in accordance with applicable regulatory requirements.

Supply vessels and helicopters will be used to transport personnel, equipment and materials to and from the active MODU(s). Supply vessels typically make regular trips to the MODU, and multiple vessels will support the MODU at any one time during drilling. Personnel will be transported to and from the MODU by helicopter or supply vessel , according to operational requirements, work schedules and rotations, and other factors. Project-related supply and support activities will take place at one or more existing, established onshore facilities operated by a third-party contractor that provides services to multiple offshore operators. No Project-specific construction or expansion of such facilities or other on-shore infrastructure is required or planned. Supply vessel and aircraft services and their transits to and from the Project Area from these onshore bases will likewise be contracted from third party suppliers and travel directly to any active drill sites in the Project Area.

The planned temporal scope of this Project, which covers the period from 2018 to 2028, has been defined so as to encompass the terms of the existing ELs identified previously (within which EA and other associated regulatory approvals must be obtained and drilling planned and commenced), as well as any potential approved extensions to these ELs, and the associated stages of well drilling, testing and abandonment or suspension as required. Within this period, the planned exploration activities that comprise this Project may occur at various times of the year for each and all years of the exploration program.

Detailed planning and procurement processes for the Project are in progress in 2018, and will continue throughout the life of the Project. Pending the receipt of applicable regulatory and corporate approvals, the identification of suitable drilling targets and other technical, logistical and commercial considerations, exploration drilling could commence on one or both of the ELs as early as 2019. It is expected that each well will require approximately 45 to 160 days for drilling and evaluation (including sidetracking and potential well testing) and associated well abandonment or suspension.

During exploration and appraisal drilling activities, sidetracking of the lower portions of the main wellbore may be required for geologic or mechanical reasons. This will be conducted by directionally drilling around obstructions in the main wellbore to either secure the original target or to intersect alternate subsurface geologic targets. Considerations such as additional time for the MODU on location as well as additional discharges associated with sidetracking have been addressed in this EIS. The 10 exploration and appraisal wells referenced above represent surface (seabed) locations and not any additional subsurface bottom hole locations associated with sidetracking from the main wellbore or subsequent sidetracked wellbores.

A more detailed description of the Project, including its overall need, purpose and justification, location, key components and activities, schedule, potential environmental emissions and their management, Project alternatives, on-going and future planning and design processes, is provided in Chapter 2 (Project Description).

1.2.3 Project Environmental Setting and Context

The Project will take place in a marine area offshore Eastern Newfoundland, and the closest western edge of the Project Area is located over 400 km from the eastern coastline of the Island of Newfoundland and over 750 km from the nearest point on the coastline of Labrador.

The following section provides a general overview of the existing environmental setting and context for the Project, as required in the EIS Guidelines (Part 2, Section 1 – Introduction and Overview), which state that this section of the EIS will “contain a description of the geographical setting in which the project will take place”, as well as specifying a number of components to be included (Section 1.3). This overview is provided here for general background and context, with further and more detailed information being provided in Chapters 5 to 7. These chapters can be referred to for further detail on these environmental components and systems, as well as for the sources of the information that is summarized below.

The Project Area has a diverse and complex geological and geomorphological setting, highly variable bathymetric conditions, and exhibits climatological, meteorological and oceanographic conditions that reflect a relatively harsh yet productive marine environment. The Project Area and surrounding marine

environments are known to be inhabited by a variety of marine biota, including marine fish, birds, mammals and sea turtles.

Marine fish and fish habitat components that are relevant to the Project Area and this EIS include plankton, benthos and finfish. The presence, abundance and distribution of particular species varies considerably based on habitat characteristics (both abiotic and biotic) and variability across this rather large and diverse marine environment, which includes parts of the Newfoundland Shelf, Flemish Cap and adjacent slope and deepwater habitats in the Flemish Pass. Within these areas and associated habitat types, a variety of fish species and assemblages occur with “shallow water” groups (e.g., lanternfish and redfish species) giving way to “slope” assemblages (e.g., Greenland halibut, lanternfish, grenadier species) and finally to “deep slope-abyssal assemblages” (e.g., blue hake, longnose eel, dogfish). Within such depth zones, habitat complexity can also be a determining factor of species presence and prevalence. The Project Area hosts a number of commercially relevant fish and shellfish species which are important for both Canadian and/or international fishers. Deep-sea corals, sea pens, and sponges are often of particular environmental interest due to the habitat-forming capacity aspects of these benthic invertebrates and their relative sensitivity to anthropogenic stressors. Existing and available information for corals, seamounts, and sponges in this region indicates that portions of the overall Project Area will overlap with several areas of known occurrence for these species.

A variety of marine and migratory bird species also occur within the Project Area and in adjacent marine and coastal regions, including seabirds and other avifauna that inhabit the region at particular or extended periods for breeding, feeding, migration and other activities. Important habitats for birds have also been identified at locations along the coastline of Eastern Newfoundland, over 400 km west of the Project Area.

The waters off Eastern Newfoundland support a diverse assemblage of marine fauna that also includes some 20 marine mammals and several sea turtle species, several of which are considered to be at risk or otherwise of special conservation concern. The existing and available information indicates that marine mammal (cetacean) species that are known or considered likely to occur within the area include a number of mysticetes (baleen whales), odontocetes (toothed whales and porpoises) and pinnipeds (seals), and several sea turtle species have also been observed. These differ considerably in their likelihood of presence and in the particular locations and habitat types that they utilize and the times at which they occur in or pass through the region.

Of these marine biota, there are currently some 23 species of fish, seven species of marine mammals, two species of sea turtles and two species of marine birds that are listed and protected under the federal *Species at Risk Act* (SARA) and/or designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) that do or could occur with some regularity within the Project Area. There are no officially designated critical habitats for any of these identified species in or near the Project Area.

A number of onland, marine and coastal areas within and off Eastern Newfoundland have been designated as protected under provincial, federal and/or other legislation and processes, or have been formally identified through relevant forums and processes as being otherwise special or sensitive due to their ecological, historical and/or socio-cultural characteristics and importance. Given its location over 400 km offshore, the Project will not occur within, or otherwise interact directly with, any of the existing provincial or federal Parks or Historic Sites (including World Heritage Sites), Ecological Reserves, Wildlife Reserves, Marine Protected Areas or Areas of Interest, Canadian/voluntary Fishing Closure

Areas, Marine Refuges, Migratory Birds Sanctuaries, Important Bird Areas (IBAs) or other locations that have been designated as protected on or around the Island of Newfoundland. The Project Area likewise does not overlap with either of the identified Ecologically and Biologically Significant Areas (EBSAs), Vulnerable Marine Ecosystems (VMEs) or preliminary Representative Marine Areas (RMAs) off Eastern Newfoundland. While the Project Area does overlap with small portions of Northwest Atlantic Fisheries Organization (NAFO) Fishery Closure Areas, there are no associated prohibitions of marine activities such as that being proposed as part of this Project.

In terms of the existing human environment, Newfoundland and Labrador is the easternmost province of Canada, and consists of the Island of Newfoundland as well as Labrador which is located to the northwest on the Canadian mainland. The province currently has a population of just over 530,000 residents, with nearly 95 percent of these living on the Island of Newfoundland. This population resides in approximately 250 municipalities and many unincorporated communities that range from fewer than five to more than 100,000 inhabitants. Along the eastern coast of Newfoundland, which faces the Project Area and adjacent marine environments, small communities are widely distributed along the coastline along with a number of larger towns and cities such as the greater St. John's area and other regional centres. The western boundary of the Project Area is located over 400 km from the closest community on the Island of Newfoundland, and 765 km from the closest community in Labrador.

Marine fisheries and other marine activities are important components of the socioeconomic environment of Newfoundland and Labrador. Commercial fisheries in the region off Eastern Newfoundland are managed by both the federal Department of Fisheries and Oceans (DFO), primarily within the 200 nautical mile EEZ, and by NAFO, primarily beyond the EEZ, while aquaculture operations in coastal areas fall under provincial jurisdiction. Commercial fisheries in and around this region are extensive and diverse, with the Project Area overlapping two NAFO Divisions and one Unit Area within each of these Divisions. The waters within and near the Project Area are the focus of fishing activities by a range of participants (both domestic and foreign) and species fisheries, primarily for snow crab and Northern shrimp in recent years (although Project Area shrimp fisheries have now been halted for conservation reasons), along with some redfish, turbot/Greenland halibut, Atlantic cod, Atlantic herring, American plaice, Atlantic halibut and others. These are both directed and by-catch fisheries using a variety of fixed (e.g. snow crab) and mobile (e.g. shrimp) gear types. Fishing activity in this area occurs year-round, but has been most concentrated in the May-July period in recent years. Seal harvesting also occurs off Eastern Newfoundland with most occurring in the spring to the north and west of the Project Area. Various fisheries science survey programs are also undertaken off Eastern Newfoundland by government and/or industry to aid with stock assessment and management decisions. Owing to the Project Area's distance from shore, no recreational/food fishery activities are known or expected to occur in or near the Project Area.

Several Indigenous groups hold DFO commercial fishing licences within NAFO Divisions that overlap with the Project Area, including licences that permit access to a variety of species and locations within NAFO 3KLMNO (see Section 7.2.1). There are no documented food, social, or ceremonial licences within or near the Project Area. The closest Indian Reserve to the Project is Miawpukek Mi'kamawey Mawi'om, located at Conne River on the south coast of Newfoundland 635 km west of the Project Area. Moreover, the Project Area, and the predicted geographic extent of any changes to the environment and associated environmental effects that may occur as a result of planned Project activities within it (see Chapters 8 –-14) do not overlap with the known traditional territories of any group, or with the land or marine areas covered by any existing land claims agreement, self-government agreement, or other

known agreements between federal or provincial governments and any Indigenous group in Newfoundland and Labrador or elsewhere.

A range of other human activities also take place on either a year-round or seasonal basis. General shipping traffic within and through the region includes marine tanker traffic and supply vessels associated with the existing offshore oil development and activities, as well as cargo ships, fishing vessel transits, and other vessel traffic. Naval training exercises also occur in the general area, and there are also known and potential unexploded ordnance (UXO) sites in the Atlantic Ocean, which include shipwrecks and submarines as well as munitions dump sites, none of which occur within the Project Area. A number of existing marine cable networks also cross through or near the region. The area off Eastern Newfoundland is also subject to considerable oil and gas exploration activity, including geophysical surveys and drilling programs, with many thousands of kilometers of seismic survey data collected and several hundred wells having been drilled to date. Offshore oil production activities have also been occurring since the 1990s, including several existing oilfields (Hibernia, Terra Nova, White Rose, Hebron). These offshore oil and gas exploration and development activities include a variety of ancillary and supporting activities as well.

This Project will take place within the offshore marine environment, which, as federal waters, are considered “federal lands” under CEAA 2012, as described in Section 1.3.1. There are no federal lands such as National Parks, Indian Reserves, Port Authorities or Canadian Forces Bases within 400 km of the Project Area.

The Project Area is again located entirely within the Study Area for the Eastern Newfoundland SEA completed by the C-NLOPB in August 2014 (Amec 2014), which has comprised a key source of information for this EIS. It is Nexen’s understanding that the Project will not take place on lands that have been subject to a regional study as described in Sections 73 to 77 of CEAA 2012.

1.3 Regulatory Framework and the Role of Government

The Project will require a number of approvals and authorizations under applicable regulatory processes, as summarized below.

1.3.1 Environmental Assessment under CEAA 2012

Proposed oil and gas exploration activities in the Canada - NL Offshore Area and elsewhere may be subject to EA review pursuant to the requirements of CEAA 2012 and its associated Regulations.

The federal EA process under CEAA 2012 focuses on potential adverse environmental effects that are within areas of federal jurisdiction, including: fish and fish habitat, migratory birds, federal lands and other changes to the environment that are directly linked to or necessarily incidental to any federal decisions about a project. CEAA 2012 also has an associated set of *Regulations Designating Physical Activities*, which identify the physical activities that constitute the "designated projects" that may require a federal EA. These Regulations specify a number of types and scales of oil and gas activities that are subject to federal EA review, including (Section 10):

> *The drilling, testing and abandonment of offshore exploratory wells in the first drilling program in an area set out in one or more exploration licences issued in accordance with the Canada–*

Newfoundland and Labrador Atlantic Accord Implementation Act or the Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act.

The Project has been determined to constitute a "designated project", and the EA of the Project under CEAA 2012 commenced in April 2017 with Nexen's submission of a Project Description and associated Summary Documents to the Agency, which were subsequently made available for government and public review. Following that review period, on June 9, 2017 the Agency determined that a federal EA was required for the Project and issued the associated Notices of EA Determination and EA Commencement, as well as Draft EIS Guidelines which were subsequently finalized on July 25 2017.

This Project involves environmental components, issues and requirements that fall within areas of federal jurisdiction. This includes, for example, the fact that Project activities are planned to take place within the offshore marine environment, which, as federal waters, are considered "federal lands" under CEAA 2012. CEAA 2012 specifically defines "federal lands" as including ".. (i) the internal waters of Canada, in any area of the sea not within a province, (ii) the territorial sea of Canada, in any area of the sea not within a province, (iii) the exclusive economic zone of Canada, and (iv) the continental shelf of Canada..". The Project also has the potential to affect environmental components such as fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles that fall under federal jurisdiction, and a number of relevant permits, authorizations and/or compliance may be required under the federal *Fisheries Act, Migratory Birds Convention Act, Species at Risk Act* and possibly others (see Section 1.5). No federal funding has been or will be requested or received by Nexen from any federal authority to support this Project.

Relevant government departments and agencies will also participate in the review of this EIS and provide information and input to the Agency for consideration at various stages of the EA review process, and in the eventual EA decision.

1.3.2 The Accord Acts

The C-NLOPB is a joint federal-provincial agency responsible, on behalf of the Governments of Canada and Newfoundland and Labrador, for petroleum resource management in the Canada – NL Offshore Area. The Accord Acts, administered by the C-NLOPB, provide for joint management of the Canada – NL Offshore Area and govern all oil and gas activities in the region. The Canada-NL Offshore Area, as defined in the Accord Acts, includes those lands within Canada's 200 nautical mile EEZ or to the edge of the continental margin, whichever is greater. As illustrated previously in Figure 1.1, the Project Area includes marine areas (lands) that are located beyond Canada's EEZ on the outer continental shelf.

The Board's responsibilities under the Accord Acts include but are not limited to: the issuance and administration of petroleum and exploration and development rights; administration of statutory requirements regulating offshore exploration, development and production; and approval of Canada-NL benefits and development plans.

1.3.2.1 Land Tenure and Licencing

The C-NLOPB administers a scheduled land tenure system in relation to rights issuance in the Canada-NL Offshore Area. The rights issuance process commences with an initial nomination of "sectors", after which there is a period of time appropriate to the cycle for exploration efforts to be undertaken. This is

followed by the issuance of an eventual call for nomination of parcels for lands within an identified sector. A Call for Bids is then issued for specific parcels, from which successful bidders are issued an EL. Nominations may otherwise be received for lands that are not offered in a scheduled cycle and a Call for Bids may be issued. Normally, the interest owner of an EL will explore that licence and, upon finding a discovery, be issued a Significant Discovery Licence to further delineate the discovery in anticipation of finding commercial resources which may lead to the issuance of a Production Licence.

Of particular relevance to the proposed offshore exploration activities that are the subject of this EIS once issued by the C-NLOPB an EL confers: 1) the right to explore for, and the exclusive right to drill and test for, petroleum; 2) the exclusive right to develop those portions of the offshore area in order to produce petroleum; and 3) the exclusive right, subject to compliance with the other provisions of the Accord Acts, to obtain a Production Licence. ELs have a maximum nine year term consisting of two consecutive periods. The interest owner is required to drill or spud and diligently pursue one exploratory well on or before the expiry date of Period I as a condition of obtaining tenure to Period II. Period I may be extended with the filing of a drilling deposit.

1.3.2.2 Authorizations and Approvals

The C-NLOPB's regulatory responsibilities also include issuing a number of authorizations and approvals pertaining to offshore oil and gas exploration and development projects and activities in the Canada-NL Offshore Area. The issuance of an EL for a particular portion of this Offshore Area does not, in and of itself, authorize the licence holder to carry out physical exploration activities (fieldwork) within that licence area. The drilling of an exploration well, for example, requires various project-specific regulatory approvals and authorizations, through which the Operator must present detailed information on its planned exploration activities, and in doing so, demonstrate that they can undertake such work in a manner that is in keeping with applicable requirements and standards for safety and environmental protection.

Before carrying out any work or activity respecting oil and gas operations, an Operator must, for example, obtain an Operating Licence (OL) which is a prerequisite for any oil and gas activity in the Canada-NL Offshore Area that involves fieldwork. Various authorizations and approvals are also required for particular activities and other matters, which may - depending on the specific nature and scope of the activity being planned - include applying for and obtaining an Operations Authorization (OA) from the C-NLOPB. In accordance with the Accord Acts and Section 6 of the *Newfoundland Offshore Petroleum Drilling and Production Regulations*, prior to the issuance of an OA the following information must be submitted by the Operator and approved by C-NLOPB:

- EA Report (completed under CEAA 2012, as applicable, or under the Accord Acts, see above);
- Canada-Newfoundland and Labrador Exploration Benefits Plan;
- Safety Plan;
- Environmental Protection Plan;
- Emergency Response and Spill Contingency Plans;
- Regulatory Financial Responsibility Requirements;
- Certificate of Fitness for the proposed equipment/facilities to be used to carry out drilling activities

Other required C-NLOPB approvals may also involve the approval of certain documents, plans or other matters as specified by the relevant legislation or regulations, or the approval of specific activities conducted under an earlier authorization. Of particular relevance to this Project, an Approval to Drill a Well (ADW) is required for operations involving drilling within or under the marine environment. A separate ADW is required for each well in a proposed drilling program, with the process involving the provision and review of specific details about the drilling program and well design. An ADW covers the operations on a well up to, and including, the termination of the well, which itself could include suspension, abandonment or completion. Other approvals, notifications or records are also required to undertake well testing, abandonment, suspension, completion or termination, or to alter the condition of a well.

There are also a number of associated Regulations under the Accord Acts which govern particular exploration or development activities, as well as various Guidelines (some of which have been jointly developed with other agencies) that are intended to address specific environmental, health, safety and economic issues related to offshore petroleum exploration and production. Section 1.5 provides a detail listing of all the relevant regulations and guidelines applicable to exploration drilling and its associated activities.

In addition to EA requirements under CEAA 2012, the C-NLOPB also requires that project-specific EAs be completed in relation to certain types of petroleum activities in the Canada-NL Offshore Area, as part of their required authorizations pursuant to Section 138(1)b of the *Canada-Newfoundland Atlantic Accord Implementation Act* and Section 134(1)b of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act.* The C-NLOPB's EA review process involves the Proponent completing an EA Report in compliance with a project-specific Scoping Document issued by the C-NLOPB, with associated input from and review by a group of provincial and federal government agencies and non-governmental organizations. It is understood that the EA for this Project under CEAA 2012 involves C-NLOPB participation, and this EIS has been designed and completed to also address the C-NLOPB's EA requirements.

Another important aspect of the C-NLOPB's mandate is the administration of the various provisions of the Accord Acts that pertain to industrial and employment benefits resulting from the exploration for, and development of, oil and gas resources in the Canada-NL Offshore Area. This includes the creation and optimization of such benefits for Canada in general and the Province of Newfoundland and Labrador in particular. The Accord Acts require that before any work or activity is authorized in this area, a Canada-Newfoundland and Labrador Benefits Plan must be submitted to, and approved by, the Board. This Plan must identify and describe the measures to be taken regarding the employment of Newfoundlanders and Labradorians and other Canadians, as well as providing manufacturers, consultants, contractors and service companies in the province and other parts of Canada with full and fair opportunity to participate on a competitive basis in the supply of goods and services to such a project. Nexen is committed to creating and optimizing opportunities and benefits for Newfoundland and Labrador and Canadian workers and companies as part of its activities and operations in the Canada-NL Offshore Area, and to carrying out its business in full compliance with relevant *Canada-Newfoundland and Labrador Benefits Plan Guidelines* and other applicable requirements. As such, Nexen will develop and implement a Canada-Newfoundland and Labrador Benefits Plan applicable to this exploration drilling project.

1.3.3 Other Potential Regulatory and Policy Requirements and Interests

Various other federal and provincial government departments and agencies may also have regulatory responsibilities, information and advice and/or other interests regarding the Project and its environmental setting and potential effects, pursuant to their associated legislation and mandates. These include the following:

- Fisheries and Oceans Canada (DFO);
- Environment and Climate Change Canada (ECCC);
- Transport Canada;
- Department of National Defence;
- NL Department of Municipal Affairs and Environment;
- NL Department of Fisheries and Land Resources; and the
- NL Department of Natural Resources

Legislation and associated regulations that are or may be relevant to the Project and its EA therefore include the:

- *Accord Acts* and associated Regulations and Guidelines (as discussed above);
- *Fisheries Act*;
- *Canadian Environmental Protection Act;*
- *Oceans Act;*
- *Navigation Protection Act;*
- *Canada Shipping Act;*
- *Migratory Birds Convention Act;* and the
- *Species at Risk Act* (Canada) and *Endangered Species Act* (NL).

A list of some of the key legislation, regulations and approvals that may be required in relation to proposed offshore oil and gas exploration drilling programs and associated activities are provided in Section 1.5.

Any applicable and relevant government policies, resource management plans, planning or study initiatives that are related to the Project, and specifically its existing environmental setting and potential environmental effects and mitigation, are discussed where relevant in the detailed description of the existing environment included in this EIS (Chapters 5-7). In addition, any cases where such legislation, regulations, policies or applicable national, provincial or regional objectives and guidelines are relevant to, and have been considered and used in, the evaluation of the environmental effects predicted in this EIS these are likewise identified and discussed in the relevant environmental effects assessment sections (Chapters 8 – 17) of this EIS.

As the Project will take place in the marine offshore environment and will not involve the development and use of any new on-land or nearshore infrastructure or Project-related expansions or modifications to same, it is not anticipated that provincial or municipal environmental regulatory interests will be triggered for this Project. Specifically, it is not expected that EA review will be required under the NL *Environmental Protection Act* (Part X), that other provincial or municipal permits or authorizations will be required, nor that any associated land use plans or land zoning will be relevant to it.

In planning and conducting its oil and gas exploration activities, Nexen will comply with these and all relevant provincial and federal legislation, regulations and guidelines, as well as applicable international conventions and standards. Nexen also has in place its own comprehensive environmental policies, plans and procedures for planning and conducting its oil and gas exploration and development activities, and requires its contractors to adhere to these as applicable.

1.4 Purpose and Organization of the EIS

This EIS is being submitted by Nexen in accordance with the provisions and requirements of CEAA 2012 and in full compliance with the EIS Guidelines.

The preparation and submission of the EIS is an important step in the EA review process for this Project. It provides the required information on the Project and its potential environmental effects and associated mitigation, including the:

- Project purpose
- Project description (components, activities, schedule)
- Project alternatives
- Changes to the Project that may be caused by the environment
- Existing environmental setting (biophysical and socioeconomic)
- Government, stakeholder, and Indigenous engagement activities, including the various comments provided
- Environmental effects of the Project (planned activities and potential accidental events)
- Mitigation measures to avoid or reduce environmental effects of the Project
- Predicted residual effects and their significance
- Predicted cumulative environmental effects
- Any proposed environmental monitoring and follow-up activities.

The EIS will form the basis for further review, consideration and discussion of the Project by governments, Indigenous and stakeholder groups, the interested public and Nexen as part of the EA process. Based on the results of the EA and the associated reviews and input, the Government of Canada will eventually decide whether (and if so, how) the Project can proceed, including any associated terms and conditions.

The EIS has been prepared and structured to provide the results of the EA and other required information in a clear, concise and well-organized manner, in keeping with current EA practice and with a view to ensuring overall readability and utility for all of its likely readers. This includes relevant government departments and agencies, Indigenous and stakeholder groups and the general public.

The EIS document is structured as follows:

> *Chapter 1 (this Introduction):* Identifies the Proponent, provides a general overview of the Project, outlines the regulatory context for the Project and its EA, and describes the purpose of the EIS and the overall organization of the document.

Chapter 2 (Project Description): Initially sets the overall context for the Project by discussing its need, purpose and rationale and alternatives. It then goes on to provide an overview and detailed description of the Project, including its location, key components and activities, schedule, potential environmental emissions and their management, Project alternatives, and on-going and future planning processes.

Chapter 3 (Governmental, Indigenous and Stakeholder Engagement): Describes Nexen's previous and on-going engagement initiatives related to the Project and its EA, as well as identifying the comments raised regarding the Project and its potential effects and where and how these are addressed in the EIS.

Chapter 4 (Environmental Assessment Scope, Approach and Methodology): Outlines the scope of the Project and its EA, including the factors considered, the scope of these factors, and the overall approach and methods used to conduct the assessment.

Chapters 5-7 (Existing Environment): Provide a description of the existing environmental setting for the Project, including the biophysical and socioeconomic environments that overlap and may interact with the Project. This includes individual chapters focussing on the existing physical (Chapter 5), biological (Chapter 6) and human (Chapter 7) environments.

Chapters 8-14 (Environmental Effects Assessments): Provide the detailed environmental effects assessments for the selected Valued Components (VCs) upon which the EIS is focussed, each of which is addressed in a separate Chapter using the EA approach and methods described earlier. This includes individual VC chapters for:

a) Marine Fish and Fish Habitat (Chapter 8)
b) Marine and Migratory Birds (Chapter 9)
c) Marine Mammals and Sea Turtles (Chapter 10)
d) Special Areas (Chapter 11)
e) Indigenous Peoples (Chapter 12)
f) Fisheries and Other Ocean Uses (Chapter 13)
g) Atmospheric Environment (Chapter 14)

Chapter 15 (Cumulative Environmental Effects): Assesses and evaluates the potential environmental effects resulting from those of the Project in combination with other relevant physical activities that have been or will be carried out.

Chapter 16 (Accidental Events): Describes and assesses possible accidental events that could occur as a result of the Project, including the results of associated modelling conducted for the Project and its EA. It also describes relevant accident prevention and emergency response plans and procedures, and assesses and evaluates the potential effects of these possible accidental events for each VC.

Chapter 17 (Effects of the Environment on the Project): Describes how environmental conditions and factors have or may influence the design and execution of the Project, and the various planning, design and operational measures that will be taken to help protect human health and safety and the environment in that regard.

Chapter 18 (EIS Summary and Conclusions): Provide a summary of the key results and conclusions of the EIS, including its predicted residual environmental effects, associated mitigation commitments, and any planned environmental monitoring and follow-up initiatives.

These EIS chapters and components have been planned and prepared as part of a fully integrated EIS document, with cross referencing throughout. Each chapter also contains its own list of references, including any literature cited and personal communications.

This EIS has been directed and submitted by Nexen, as the Proponent, and was prepared by an EIS Study Team comprised of personnel from Amec Foster Wheeler Environment and Infrastructure and several specialized subcontractors. An overview of the key personnel that have been involved in the planning and writing of this EIS is provided in Appendix A.

1.5 Key Legislation, Regulations and Associated Approvals

Table 1.2 provides a list of key legislation, authorizations and associated approvals that may be required in relation to proposed offshore oil and gas exploration drilling programs and associated activities, including those which are being planned as part of this Project.

Table 1.2 Summary of Potentially Applicable Legislation, Regulations and Guidelines

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Specific to Oil and Gas Activities in the Canada-NL Offshore Area			
Accord Acts	C-NLOPB	The C-NLOPB is responsible, on behalf of the Governments of Canada and Newfoundland and Labrador, for petroleum resource management in the Canada-NL Offshore Area. The Accord Acts, administered by the C-NLOPB, govern all petroleum operations in that offshore area. The mandate of the C-NLOPB is to interpret and apply the provisions of the Accord Acts to all activities of operators in the Canada-Newfoundland and Labrador Offshore Area and, to oversee operator compliance with those statutory provisions. The Board's role is to facilitate the exploration for and development of petroleum resources in the Canada-Newfoundland and Labrador Offshore Area in a manner that is consistent with the C-NLOPB's mandate including: • health and safety of workers • environmental protection;	The various regulations and guidelines described below have been developed and issued under the Accord acts (and in some cases, also with other relevant legislation) The regulatory approvals and authorizations identified below may also be required pursuant to Section 138(1)(b) of the *Canada-Newfoundland Atlantic Accord Implementation Act* and Section 134(1)(b) of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* and the various regulations made under the Accord Acts.

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
		• effective management of land tenure; • maximum hydrocarbon recovery and value; and, • Canada/Newfoundland and Labrador benefits.	
Accord Act Regulations	C-NLOPB	A number of Regulations made under the Accord Acts may be relevant to offshore oil and gas exploration drilling and associated activities, including the following: • Certificate of Fitness • Drilling and Production Regulations • Marine Installations and Structures Transitional Regulations • Occupational Health and Safety Transitional Regulations • Offshore Petroleum Administrative Monetary Penalties Regulations • Offshore Petroleum Cost Recovery Regulations • Offshore Petroleum Financial Requirements Regulations • Oil and Gas Operations • Oil and Gas Spills and Debris Liability • Petroleum Geophysical Operations • Petroleum Installations • Requirements Respecting the Security of Offshore Facilities	The regulatory approvals and authorizations identified below may also be required pursuant to the relevant sections of the Accord Acts and/or one or more Regulations made under the Accord Acts. An Operating Licence, for example, is a prerequisite for oil and gas activity in the Canada-NL Offshore Area that involves fieldwork. The statutory requirements pertaining to Operating Licences are specified in Sections 137 and 138 of the Atlantic Accord Act and in the *Newfoundland Offshore Area Oil and Gas Operations Regulations.* There are also three types of authorizations administered by the C-NLOPB: 1) Operations Authorization (OA) 2) Geophysical Program Authorization 3) Diving Program Authorization An OA may include authorization for a drilling program, production project, well operations or other activities or components that are not covered by other types of authorizations. Also, Operators applying to undertake a geophysical program, a wellsite seabed survey, VSP, an electromagnetic program, any other type of geological or geophysical program (including those that do not involve fieldwork), a geotechnical program or an environmental program, may apply for a Geophysical Program Authorization. C-NLOPB approvals may also involve the approval of certain documents, plans or other matters as specified by the legislation or regulations, or the approval of specific activities conducted under an earlier authorization. These include an:

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
			• Approval to Drill a Well (ADW) • Approval to Alter the Condition of a Well • Approval of a Formation Flow Testing Program • Approval of a Canada-Newfoundland and Labrador Benefits Plan Of relevance to this Project, an ADW is required for operations involving drilling within or under the marine environment. An ADW covers the operations on a well up to, and including, the termination of the well, which itself could include suspension, abandonment, or completion. A wellsite seabed survey must be completed prior to the issuance of such an ADW. If the well is to be tested, Approval of a Formation Flow Testing Program is also required in accordance with the *Newfoundland Offshore Petroleum Drilling and Production Regulations*.
Offshore Waste Treatment Guidelines (OWTG)	C-NLOPB	These guidelines outline recommended practices for the management of waste materials from oil and gas drilling and production facilities operating in the Canada-NL Offshore Area. The OWTG were prepared in consideration of the offshore waste/effluent management approaches of other jurisdictions, as well as available waste treatment technologies, environmental compliance requirements, and the results of environmental effects monitoring programs in Canada and internationally. The OWTG specify performance expectations for the following types of discharges (NEB *et al* 2010): • emissions to air • produced water and sand • drilling muds and solids • storage displacement water • bilge water, ballast water and deck drainage • well treatment fluids • cooling water • desalination brine	Adherence to Guidelines

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
		• sewage and food wastes • water for testing of fire control systems • discharges associated with subsea systems • naturally occurring radioactive material	
Drilling and Production Guidelines (updated August 2017)	C-NLOPB	These guidelines were developed and implemented by the C-NLOPB and Canada-Nova Scotia Offshore Petroleum Board to provide criteria for compliance requirements for operators planning to conduct offshore drilling activities on the east coast of Canada. Offshore oil and gas activities that involve drilling (including exploration and production) must be in compliance with the Drilling and Production Guidelines, in order to attain an approval to drill a well and an Operations Authorization. These guidelines are based on past experiences in offshore oil and gas, legislation from the C-NLOPB, and from industry best practice. These guidelines provide direction and compliance standards for all aspects of offshore exploration drilling, including, but not limited to: • well approval applications • well installations, facilities, support craft • drilling fluid systems • riser specifications • drilling practices • formation flow testing equipment • well control • well casing and cementing design and processes • well abandonment • flaring • surveys • reporting and data requirements The guidelines also cover aspects of production activities, should production be planned in the case of a discovery.	Adherence to Guidelines

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG)	C-NLOPB	These guidelines provide a framework for chemical selection that reduces the potential for environmental effects from the discharge of chemicals used in offshore drilling and production operations. The framework incorporates criteria for environmental acceptability that were originally developed by the Oslo and Paris Commissions (OSPAR) for the North Sea. An operator must meet the minimum expectations outlined in the OCSG as part of the authorization for work or activity related to offshore oil and gas exploration and production.	Adherence to Guidelines
Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (Updated November 2017)	C-NLOPB	These guidelines describe compensation sources available to potential claimants for loss or damage related to petroleum activity offshore Newfoundland and Labrador, and outline the regulatory and administrative roles which the Board exercises respecting compensation payments for actual loss or damage directly attributable to offshore operators.	Adherence to Guidelines
Environmental Protection Plan Guidelines	C-NLOPB	These guidelines assist operators in developing Environmental Protection Plans (EPP) to meet the requirements of Sections 6 and 9 of the *Drilling and Production Regulations*	Adherence to Guidelines
Canada-Newfoundland and Labrador Exploration Benefits Plan Guidance	C-NLOPB	This document provides an operator engaged in petroleum exploration activities, including geophysical, geotechnical, and drilling, in the Canada-NL Offshore Area with guidance for the preparation of a Canada-Newfoundland and Labrador Benefits Plan (Benefits Plan) which is required under Section 45 of the Accord Acts. The guidance also addresses related contracting, expenditure, and employment reporting requirements.	Adherence to Guidance
Geophysical, Geological, Environment	C-NLOPB	These Guidelines have been prepared to assist Applicants who wish to conduct geophysical,	Adherence to Guidelines and associated Geophysical Program Authorization

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
al and Geotechnical Program Guidelines (Updated April 2017)		geological, geotechnical, or environmental programs within the offshore area. They replace those issued by the C-NLOPB in January 2012	
Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP)	DFO / ECCC / C-NLOPB	The SOCP specifies the minimum mitigation requirements that must be met during the planning and conduct of marine geophysical surveys, in order to reduce effects on life in the oceans. These mitigation measures can be applied to VSP operations. These requirements focus on planning and monitoring measures to avoid interactions with marine mammal and sea turtle species at risk where possible and reduce adverse effects on species at risk and marine populations.	Adherence to SOCP
Guidelines Respecting Financial Requirements (amended August 2017)	C-NLOPB	Operators wishing to conduct work or activity in the Canada-NL Offshore Area are required to provide proof of financial responsibility in a form and amount satisfactory to the Board. These regulations and guidelines provide guidance to operators in providing proof of financial requirements regarding authorization being sought for work or activity relating to drilling, development, decommissioning or other operations in the offshore areas.	Adherence to Guidelines
Other Guidelines	C-NLOPB	Other Guidelines administrated by the C-NLOPB that do or may apply to aspects of offshore exploration programs such as those being proposed as part of this Project include: • Measures to Project and Monitor Seabirds in Petroleum-Related Activity in the Canada – Newfoundland and Labrador Offshore Area • Atlantic Canada Standby Vessel Guidelines • Cost Recovery Guidelines • Data Acquisition and Reporting Guidelines	Adherence to Guidelines as applicable

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
		• Incident Reporting and Investigation Guidelines • Measurement Under Drilling and Production Regulations • Monitoring and Reporting • Physical Environmental Programs • Research and Development Expenditures • Safety Plan Guidelines • Transboundary Crewing • Codes of Practice for Atlantic Canada Offshore Petroleum Standard Practice for the Training and Qualifications of Offshore Personnel • Code of Practice for Transportation of Employees via Vessel to or from a Workplace	
Other Relevant Legislation			
CEAA 2012	CEA Agency	"The drilling, testing and abandonment of offshore exploratory wells in the first drilling program in an area set out in one or more exploration licences" is included in the list of designated activities under CEAA 2012. The Agency has determined that exploratory drilling for the Project requires an EA under CEAA 2012.	The Project is contingent upon EA approval (i.e., an EA Decision Statement that allows the Project to proceed).
Canadian Environmental Protection Act, 1999 (CEPA, 1999)	ECCC	CEPA, 1999 pertains to pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. Among other items, CEPA, 1999 provides a wide range of tools to manage toxic substances, and other pollution and wastes, including disposal at sea.	Disposal at Sea Permits (under the *Disposal at Sea Regulations* pursuant to CEPA, 1999) have not been required in the past for operational discharges of drill muds or cuttings. Therefore, such a permit is not anticipated to be required in support of the Project.
Energy Safety and Security Act (S.C. 2015, c. 4)	NRCan	Introduced in Parliament as Bill C-22, *Energy Safety and Security Act* received Royal Assent on February 26, 2015 and came into effect on February 26, 2016. *Energy Safety and Security Act* aims to strengthen the safety and security of offshore oil production through improved oil spill prevention, response, accountability, and transparency	Financial Responsibility and Financial Resources requirements have increased. Specific additional relevance to be determined, but likely to have specific implications for spill prevention and response.

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
		and amends the Accord Acts and the *Canadian Oil and Gas Operations Act* with the intent of updating, strengthening, and increasing the level of transparency of the liability regime that is applicable to spills and debris in the offshore areas. The Act also promotes harmonization of the EA process for offshore oil and gas projects and includes provisions to allow the offshore petroleum boards to enable them to conduct EAs under CEAA 2012.	
Fisheries Act	DFO ECCC (administers Section 36, specifically)	The *Fisheries Act* contains provisions for the protection of fish, shellfish, crustaceans, marine mammals, and their habitats. Under the *Fisheries Act*, no person shall carry on work, undertaking, or activity that results in serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery, or to fish that support such a fishery, unless this activity has been authorized by the Minister of Fisheries and Oceans. Section 36 of the *Fisheries Act* pertains to the prohibition of the deposition of a deleterious substance into waters frequented by fish.	Authorization from the Minister of Fisheries and Oceans under section 35(2) of the *Fisheries Act* has not been required in the past for offshore exploration drilling projects. Therefore, such an authorization is not anticipated to be required in support of the Project.
Migratory Birds Convention Act (MBCA)	ECCC	Under the MBCA, it is illegal to kill migratory bird species not listed as game birds or destroy their eggs or young. The Act also prohibits the deposit of oil, oil wastes or other substance harmful to migratory birds in waters or area frequented by migratory birds.	The salvage of stranded birds during offshore Project operations will require a handling permit under section 4(1) of the *Migratory Birds Regulations* pursuant to the MBCA.
Canada Shipping Act (CSA)	Transport Canada (TC)	The *Canada Shipping Act, 2001* and related regulations set out the requirements for safety and environmental protection for Canadian vessels and their operator	Project components and activities will be required to comply with the relevant requirements of the Act and its regulations.
Navigation Protection Act (NPA)	TC	The NPA came into force in April 2014 and replaced the former *Navigable Waters Protection Act*. The NPA is intended to protect specific inland and nearshore navigable waters (as identified on	No applicable permitting requirements have been identified for the Project, as the Project Area is located offshore, outside of the Scheduled Waters specified in the NPA.

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
		the list of "Scheduled Waters" under the NPA) by regulating the construction of works on those waters and by providing the Minister of Transport with the power to remove obstructions to navigation.	
Oceans Act	DFO	The *Oceans Act* provides for the integrated planning and management of ocean activities and legislates the marine protected areas (MPA) program, integrated management program, and marine ecosystem health program. MPAs are designated under the authority of the *Oceans Act*.	No applicable permitting requirements have been identified for the Project.
Species at Risk Act (SARA)	DFO/ECCC /Parks Canada	SARA is intended to protect species at risk in Canada and their "critical habitat" (as defined by SARA). The main provisions of the Act are scientific assessment and listing of species, species recovery, protection of critical habitat, compensation, permits and enforcement. The Act also provides for development of official recovery plans for species found to be most at risk, and management plans for species of special concern. Under the Act, operators are required to complete an assessment of the environment and demonstrate that no harm will occur to listed species, their residences or critical habitat or identify adverse effects on specific listed wildlife species and their critical habitat, followed by the identification of mitigation measures to avoid or reduce effects. All activities must be in compliance with SARA. Section 32 of the Act provides a complete list of prohibitions.	Under certain circumstances, the Minister of Fisheries and Oceans may issue a permit under section 73 of SARA authorizing an activity that has potential to affect a listed aquatic species, part of its critical habitat, or the residences of its individuals. However, such a permit is not anticipated to be required in support of the Project.
NL Endangered Species Act	NL Department of Fisheries and Land Resources	The provincial *Endangered Species Act* provides special protection for plant and animal species considered to be endangered, threatened, or vulnerable in the province. The Act applies to species, sub-species and populations that are native to the province but does not include	No applicable permitting requirements have been identified for the Project.

Legislation/ Regulation/ Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
		marine fish, bacteria, and viruses. It also does not apply to introduced species, except in extraordinary circumstances. Designation under the Act follows recommendations from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and/or the Species Status Advisory Committee (SSAC) on the appropriate assessment of a species. Currently there are 35 species, subspecies, and populations listed under the Act. Thirteen of these species are listed as endangered, nine are listed as threatened and thirteen are listed as vulnerable.	
Seabird Ecological Reserve Regulations, NLR 66/97	NL Department of Fisheries and Land Resources	Prohibit or limit industrial development and certain activities that can cause disturbance to breeding seabirds, including hiking, boat traffic and low-flying aircraft near the colonies during the breeding season, and the use of ATVs at all times.	No applicable permitting requirements have been identified for the Project.

1.6 References

Amec Environment and Infrastructure (2014). Eastern Newfoundland Strategic Environmental Assessment. Prepared for Canada-Newfoundland and Labrador Offshore Petroleum Board.

NEB (National Energy Board), C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board) and C-NSOPB (Canada-Nova Scotia Offshore Petroleum Board). (2010). Offshore Waste Treatment Guidelines. Calgary, AB.

2 PROJECT DESCRIPTION

This chapter provides a description of the Project, including its purpose and benefits, location, key components and activities, schedule and alternatives. It also includes a discussion of the various potential environmental emissions that may be associated with planned Project activities, as well as proposed means for their management through Project planning and design, and during its eventual implementation.

2.1 Project Scope and Overview

As discussed in Section 1.2, Nexen is planning to conduct a program of petroleum exploration drilling and associated activities in the eastern portion of the Canada-NL Offshore Area. The Project will include exploration drilling within two Exploration Licences (ELs 1144 and 1150) held by Nexen in the Flemish Pass region, as well as possible appraisal (delineation) drilling in the event of a hydrocarbon discovery, VSP, well testing, eventual well abandonment (or suspension) procedures, and associated supply and service activities. Subject to regulatory approvals, Nexen or any future partners may serve as Operator during this Project. The Operator will honour all commitments, mitigations and regulatory requirements for any Project activities that are the subject of this EIS, including any terms and conditions of EA approval .

The scope of the designated project for the purposes of this EIS has been outlined in Part 1, Section 3.1 of the EIS Guidelines and includes:

- *The mobilization, operation and demobilization of Mobile Offshore Drilling Unit(s) designed for year-round operations for the drilling, testing and abandonment of up to ten wells (exploration or delineation) within exploration licences operated by Nexen Energy ULC (1144 and 1150), including consideration of any proposed safety exclusion zones. Drilling may occur in various water depths under consideration, with various types of drilling units, and with multiple drilling units operating simultaneously;*

- *Vertical seismic profiling surveys and in-water works (e.g. well evaluation and testing) to support the specific exploration wells under consideration, but excluding surveys potentially required to support conduct of the EA (e.g. environmental baseline surveys) and surveys related to the broader delineation of resources (e.g. use of 2D high-resolution reflection seismic, sub-bottom profilers, side-scan sonar, multi-beam echosounder, magnetometers); and*

- *The loading, refuelling and operation of marine support vessels (i.e. for re-supply and transfer of materials, fuel, and equipment; on-site safety during drilling activities; and transport between the supply base and Mobile Offshore Drilling Unit(s)) and helicopter support (i.e. for crew transport and delivery of light supplies and equipment) including transportation to the Mobile Offshore Drilling Unit(s).*

As part of its planned, overall program of oil and gas exploration activities off Eastern Newfoundland, Nexen is also proposing to carry out an *Eastern Newfoundland Offshore Geophysical, Geochemical, Environmental and Geotechnical Program (2018 - 2027),* which is undergoing concurrent but separate EA review under the regulatory requirements of the C-NLOPB pursuant to the Accord Acts. As the proposed survey activities that comprise that separate project are initiated and completed and their

results are analysed and interpreted, possible wellsite locations within ELs 1144 and 1150 may be identified by Nexen and evaluated further through wellsite surveys. These may be carried out using 2D high-resolution reflection seismic, sub-bottom profilers, side-scan sonar, multi-beam echosounder and/or magnetometers, and are included within the scope of that project and its separate EA review by the C-NLOPB.

2.2 Project Purpose and Benefits

Nexen's current offshore interests in Eastern Canada include two existing ELs off Eastern Newfoundland (EL 1144 and EL 1150) which were issued by the C-NLOPB effective January 15, 2016 and January 15, 2017, respectively. Nexen is currently the sole interest holder in EL 1144 and EL 1150, which have a combined total work expenditure commitment of over $300 million.

The petroleum industry is an important and valuable component of the Newfoundland and Labrador economy, and one that has been identified as having considerable potential for future growth. Over the past approximately five decades (1966-2016), offshore area program expenditures (including exploration, pre-development, development and production activities) have totalled over $56 billion, including over $8.5 billion in exploration spending during that period (C-NLOPB 2017). The oil and gas industry (including production, exploration and support activities) is currently the largest contributor to Newfoundland and Labrador's gross domestic product (GDP), accounting for nearly 17 percent of the province's nominal GDP in 2015 (or, over $4 billion). Annual average employment in the industry in 2016 was approximately 7,000 person-years, or three percent of total provincial employment (NLSA 2017). The future growth of the province's oil and gas industry has also been recognized as a key priority area of focus, as reflected and summarized in various plans, strategies and other documents produced by the Government of Newfoundland and Labrador and others, including *Newfoundland and Labrador's Energy Plan, Focusing Our Energy* (NL DNR 2007), *The Way Forward: A Vision for Sustainability and Growth in Newfoundland and Labrador* (Government of NL 2016) and other relevant plans and strategies. In terms of the latter, for example, a key action item identified in that provincial strategy document includes the objective of "Position[ing] Newfoundland and Labrador globally as a preferred location for oil and gas development" (Action 2.21, page 27)

Further exploration offshore Newfoundland and Labrador is required in order to identify and further understand the existence of currently unknown and undeveloped hydrocarbon reserves in the region, and in doing so, to help facilitate the continued development of this important economic sector. Exploration drilling activities such as those proposed here are a necessary initial step in seeking to confirm the potential existence of commercially viable hydrocarbon reserves at any location. While offshore seismic programs and other exploration activities and datasets can be used to identify areas with the potential to contain oil and gas resources, they cannot on their own confirm the presence of hydrocarbon resources at any site. Exploration drilling is necessary to determine and define any such resources that may be present, as the basis for further evaluation, delineation and possible future development of offshore oil and gas reserves.

As a relatively new entrant into Newfoundland and Labrador's oil and gas sector, Nexen is seeking to increase its presence and activities in the region through exploration, and if commercially viable hydrocarbon resources are successfully identified, through future development and production activities. Nexen-held land holdings within the Flemish Pass are thought to have the potential to contain important hydrocarbon reserves. In proposing, planning and undertaking this Project, Nexen's primary

objectives are therefore to acquire additional information to better understand the overall hydrocarbon potential of the Project Area, and specifically, to help determine the potential presence, nature and volume of possible oil and gas reserves within these two ELs. The approval and implementation of the Project is also required to allow the licence interest holder, to meet its work expenditure commitments to the provincial and federal governments (through the C-NLOPB) that must be fulfilled over the term of these licences (Section 1.3.2).

In the near term, the proposed petroleum exploration activities that comprise this Project and which are the subject of this EIS will result in a number of important direct and indirect economic benefits, including the creation of employment and business opportunities over the course of its planning and operational phases in 2018 and beyond. Nexen has recently established an office in St. John's NL that is currently staffed with four employees. During Project planning and eventual operations, it is expected that this number will increase, along with other Nexen employees based elsewhere that will participate in various aspects of Project planning and implementation.

As the Project progresses into its operations phase, much of the work activity associated with the Project will be completed by Nexen contractors, who will be evaluated and selected through the Company's commercial procurement processes based on their qualifications, experience, safety and environmental systems and performance and other factors relevant to the specific nature of the work and deliverables in question. Some of the key contracts that will eventually be awarded as part of the planning and implementation of the exploration activities that comprise this Project include:

- Helicopter services
- Shore base services
- Drill bits
- Fuel
- MODU positioning
- Casing handling
- Directional drilling/logging while drilling (LWD) and measurements while drilling (MWD) services
- Well control services
- Tubulars and tubular management
- Medical services
- Personal protective equipment (eg, survival suits)
- Drilling fluids and services
- Weather forecasting and oceanographic services
- Liner hanger equipment and services
- Warehousing, freight, customs, brokerage
- Coring Services
- Drill string / landing string
- Ice/Metocean Services
- Third party inspection / testing
- Cement
- Wellheads
- Wireline services
- Core analysis
- Waste management

- Solids control
- Mudlogging
- Remotely Operated Vehicle (ROV) Services
- Supply vessels
- Float equipment

The number of personnel onboard an active MODU during offshore exploration drilling can range from approximately 100 to 200 persons, with an equal or greater number of other support personnel also involved in relevant aspects of these activities. A further description of anticipated personnel requirements on the MODUs, supply vessels and other aspects of the Project is provided later in Section 2.6. In addition, these direct and indirect employment and business benefits will be further supplemented by "spin-off" economic benefits as these incomes and revenues move throughout the provincial and national economies.

Nexen believes in sharing the economic benefits of its business activities with the people closest to its operations – which provides a "win-win" for the company and neighbouring communities. In this way, Nexen benefits from the proximity of local suppliers and working with people who know the local culture, community and environment the best. In turn, communities benefit from direct and indirect employment and diversification of the local economy that our company generates. Many of Nexen's investment initiatives are focused on building capacity within the community, from encouraging youth to stay in school, to assisting in technical training program delivery. The goal is to encourage healthy communities with local businesses that are able to compete for work that meets Nexen's health, safety, environmental, quality, technical and commercial requirements.

Full and fair opportunities for employment and the provision of services and supplies to this Project will be provided to Newfoundlanders and Labradorians in accordance with Section 45 of the Accord Acts. Nexen is committed to creating and optimizing opportunities and benefits for Newfoundland and Labrador and Canadian workers and companies as part of its activities and operations in the Canada-NL Offshore Area, and to carrying out its business in full compliance with the Accord Acts and with the provisions of the C-NLOPB's *Canada-Newfoundland and Labrador Exploration Benefits Plan Guidance* (Appendix 1 of the Canada-NL Benefits Plan Guidelines, February 2016) and other applicable requirements. Employment associated with the Project will be communicated to local and regional audiences through various forums. First consideration will be given to residents of Newfoundland and Labrador and Canada as a whole, where they have the appropriate qualifications and experience. Similarly, opportunities for the provision of goods and services will be communicated locally and regionally, and first consideration will be given to provincially-based suppliers where the goods and services are cost-competitive and are of a standard of quality suitable for the Project.

Should the exploration activities being proposed as part of this Project be successful in identifying important and commercially viable oil and/or gas resources in the region, they could also lead to additional economic activity in Newfoundland and Labrador and elsewhere related to further exploration, and possibly, petroleum production activities. An important potential outcome of this Project could therefore be future economic development and growth in the province's offshore oil and gas sector and overall economy.

In that regard, and in addition to its potential socioeconomic benefits on local, regional, and national scales, the Project may also therefore help to play a part in contributing to overall energy supply and

diversity in Canada and beyond. Global energy demand is projected to grow by more than one-third by 2035, and fossil fuels are expected to remain a dominant part of the world's energy mix (Nexen 2017). Nexen is in the business of responsibly producing oil and natural gas to help meet this demand. As a wholly-owned subsidiary of CNOOC Limited, Nexen is in an even stronger position to develop its assets and pursue growth opportunities in a way that generates far-reaching economic benefits including direct and indirect job creation, goods and services contracting, the payment of taxes and royalties, and community investment.

The Project will also have important technological and educational implications for the province's oil and gas sector as a whole. The exploration drilling and other activities that will be conducted as part of the Project are expected to utilize standard and proven exploration methods. It will, however, involve drilling and associated activities in the Flemish Pass region, which is a key area of interest in the Canada-NL Offshore Area that is located outside of the primary offshore basins that have been the focus of much of the previous exploration and all offshore production activity to date. The planning and implementation of this Project will therefore help further advance the industry's expertise and experience in conducting exploration drilling in these areas and their associated environmental conditions, as well as contributing important information on the geological characteristics and overall hydrocarbon potential of this part of the Canada-NL Offshore Area.

The Project represents an environmentally and socially responsible, technically feasible and economically beneficial means of conducting offshore exploration drilling and other associated activities with Nexen's existing ELs in the Flemish Pass region. It will allow Nexen to meet its exploration and expenditure obligations under the terms of these licences, while at the same time providing important direct and indirect socioeconomic benefits to the province as well as contributing information and experience to help advance the future development of Newfoundland and Labrador's offshore oil and gas industry and the overall economy of the Atlantic region and Canada.

2.3 Project Location and Designated Project Area

The Project Area (Figures 2.1 and 2.2) is defined as the overall geographic area within which all Project-related exploration activities will take place. It covers an offshore area of approximately 10,634 km^2, with its western edge being over 400 km east of the Island of Newfoundland. The Project Area fully incorporates ELs 1144 and 1150 (Table 2.1), with current plans being to drill up to 10 wells on the two ELs. Specific wellsite numbers, types and locations will be determined as Project planning activities continue.

The Project Area includes a 20 km buffer area surrounding the two licences to (conservatively) accommodate the location and extent of ancillary activities that may be carried out in support of such drilling activities (Table 2.1) These may include, for example, any Project components or activities that are required to extend beyond the immediate boundaries of the ELs themselves, such as the required temporary presence and movement of the MODU(s) or supply vessels and aircraft during initial mobilization and set up, any eventual movements during drilling ,and the eventual demobilization from the drill site, as well as any required non-drilling activities such as VSP that could conceivably extend to outside the boundaries of the EL. All drilling operations carried out as part of the scope of this Project will, however, be conducted within the defined boundaries of the ELs themselves. The EIS also considers related supply vessel and aircraft traffic to and from this offshore Project Area (Section 2.5.2.6).

Figure 2.1 Project Area and Associated Exploration Licences

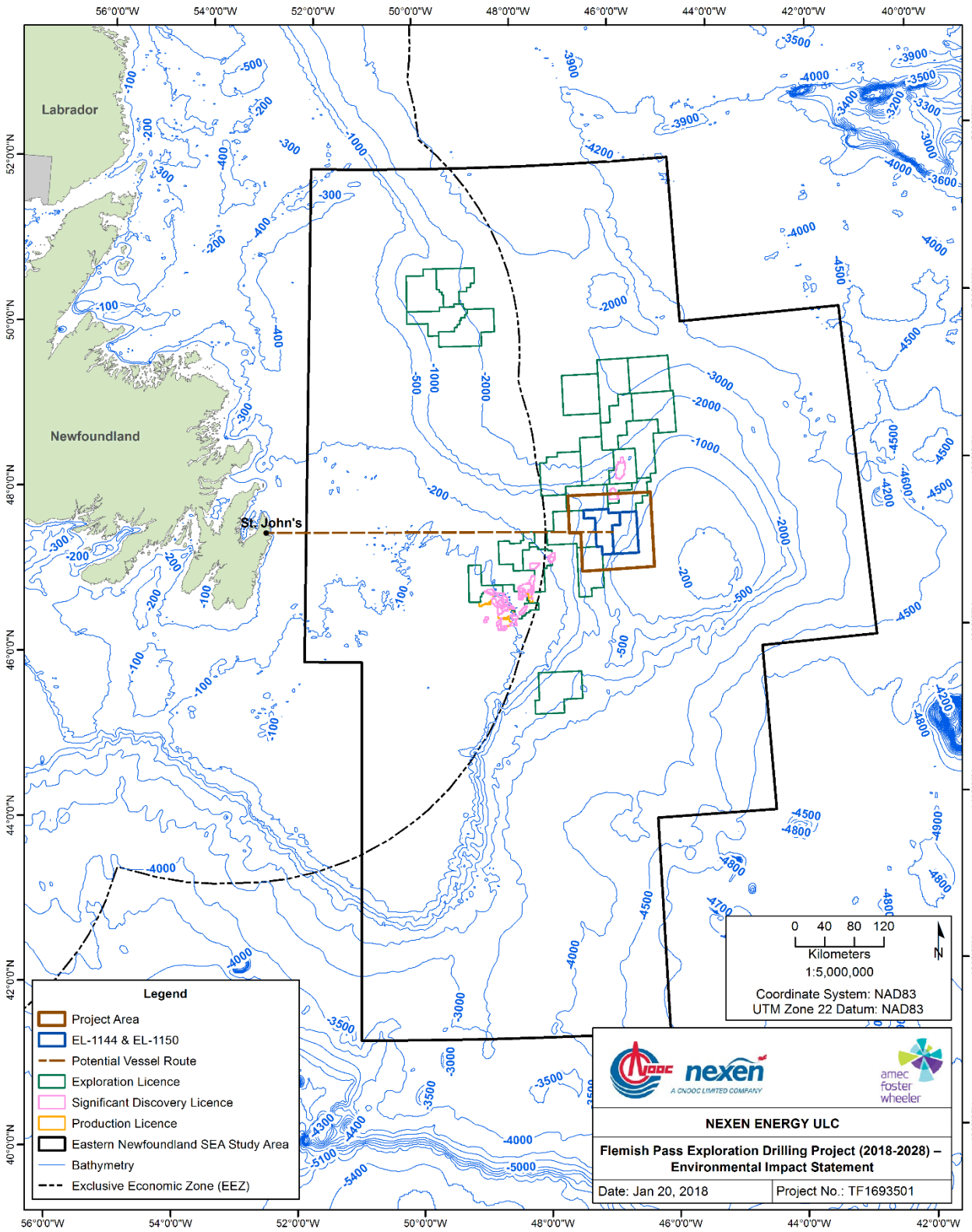


Figure 2.2 Project Area and Associated Exploration Licences (*Zoomed in Version*)

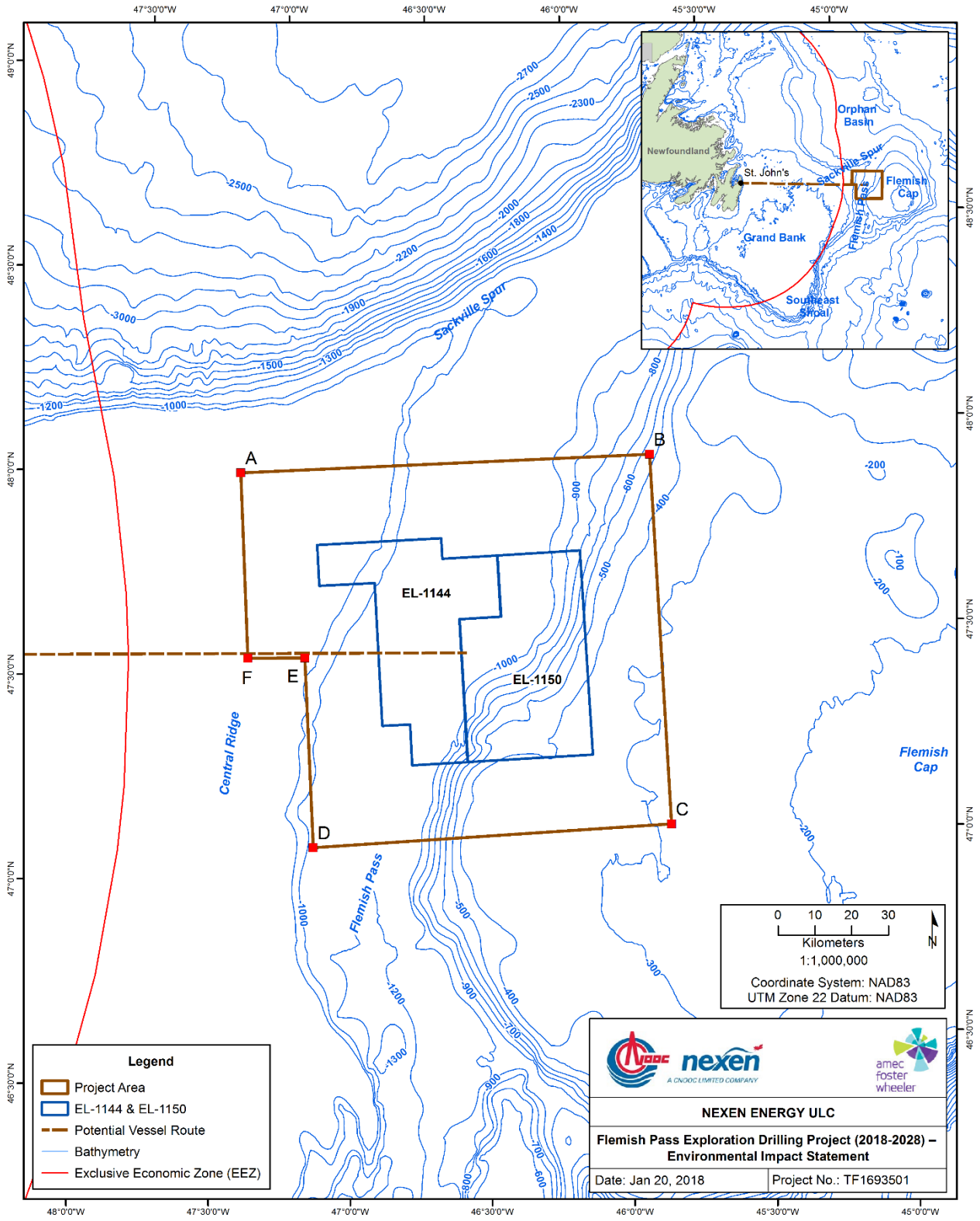


Table 2.2 provides "corner point" coordinates for the Project Area, while Table 2.3 provides the official coordinates (from the C-NLOPB) of each of the ELs that comprise the Project.

Table 2.1 Nexen Exploration Licences off Eastern Newfoundland

Exploration License	Distance from Island of Newfoundland	Licence Area		Approximate Water Depth (m)	
		Hectares	Km^2	Max	Min
EL 1144	423 km	163,008	1,630.08	1,200	650
EL 1150	460 km	169,578	1,695.78	1,185	330
Project Area					
Remainder of Project Area (Minus ELs)	405 km	730,840	7,308.40	1,190	250
Project Area (Total)	405 km	1,063,426	10,634.26	1,200	250

Table 2.2 Nexen Project Area Corner Point Coordinates

Point *	Latitude	Longitude	Easting	Northing
A	47° 58' 8.5" N	47° 15' 46.3" W	778921	5319618
B	47° 57' 23.1" N	45° 46' 27.9" W	890078	5324683
C	47° 3' 5.7" N	45° 47' 6.1" W	896049	5224107
D	47° 2' 40.6" N	47° 4' 7.0" W	798621	5217624
E	47° 30' 32.5" N	47° 3' 50.7" W	796357	5269245
F	47° 30' 56.4" N	47° 16' 11.5" W	780829	5269218
* See Figure 2.2 Note: UTM Coordinates in NAD83 UTM Zone 22N.				

Table 2.3 Nexen Exploration Licences 1144 and 1150 Coordinates

Exploration Licence	Latitude	Longitude
EL 1144	47°50'N	46°15'W
	47°50'N	46°30'W
	47°50'N	46°45'W
	47°40'N	46°15'W
	47°40'N	46°30'W
	47°40'N	46°45'W
	47°30'N	46°30'W
	47°30'N	46°45'W
	47°20'N	46°30'W
EL 1150	47°50'N	46°00'W
	47°50'N	46°15'W
	47°40'N	46°00'W
	47°40'N	46°15'W
	47°30'N	46°00'W
	47°30'N	46°15'W
	47°20'N	46°00'W
	47°20'N	46°15'W

Exploration Licence	Latitude	Longitude
**North American Datum 1927 *Legal Disclaimer* The C-NLOPB does not represent or guarantee that any information contained in this document is accurate, complete or a true copy. Users are advised to contact the Registrar or Deputy Registrar at (709) 778-1400 to obtain certified copies or to visit the Registry at the C-NLOPB offices to view official records.		

While the Project Area is defined as an overall polygon that encompass all such activities over the course of the Project, the various components and activities associated with the drilling of each individual well and other planned aspects of the Project will occupy fairly small areas within this overall area, as described later in this chapter.

As shown in Figure 2.1, the Project Area is located entirely within the Study Area for the Eastern Newfoundland SEA completed by the C-NLOPB in August 2014 (Amec 2014).

In addition to the boundaries of the Project Area itself, the EIS also defines and considers EA Study Areas for the various environmental components that are assessed (Section 4.3.1.1). The spatial boundaries are identified and further described in Chapters 8 to 14, and are based on consideration of the nature and extent of the various environmental components that may be affected by the Project, as well as the potential geographic zone of influence of Project components and activities (both planned and potential accidental events) and their environmental interactions.

2.4 Adjacent Resource Uses

A general listing and overview of some of the key environmental features within and adjacent to the Project Area was provided previously in Section 1.2.3. As required by the EIS Guidelines (Part 2, Section 1.3), a brief summary of adjacent resource users is provided here.

Commercial fisheries in this region are diverse, with the Project Area overlapping two NAFO Divisions (3L and 3M) and two Unit Areas within these Divisions (3Li and 3Ma, with fishing activities that involve two jurisdictions and management regimes (Canada and NAFO), and diverse species, gear types and other characteristics at various times of the year. A number of Indigenous groups hold commercial fishing licences that permit access to a variety of species and locations within NAFO 3KLMN. There are no known food, social, or ceremonial licences within or near the Project Area. Various fisheries science survey programs are also undertaken off Eastern Newfoundland by government and/or industry to aid with stock assessment and management decisions. Owing to the Project Area's distance from shore, no recreational/food fishery activities are known or expected to occur in or near the Project Area. A variety of other human components and activities also occur on either a year-round or seasonal basis, including general shipping traffic, naval training exercises, marine cable networks, and other oil and gas exploration activities.

2.5 Project Components and Activities

The key components and activities that comprise this Project include exploration drilling, possible appraisal (delineation) drilling in the event of a hydrocarbon discovery, VSP surveys, well testing, eventual well abandonment or suspension procedures, and associated supply and service activities.

Exploration wells are drilled to determine whether areas of interest identified from previous geophysical surveys and other information contain oil and gas resources. Depending on the results of these wells, an operator may then drill appraisal wells into different parts of the identified hydrocarbon accumulation to confirm its size and the characteristics of the oil or gas resources found.

2.5.1 MODU Selection Process and Possible Drilling Units

There are a number of types of MODUs that may be used for offshore exploration drilling programs off Eastern Newfoundland, with the selection of MODU type often based primarily on the nature of the physical environment at the proposed drill site, particularly water depth, expected drilling depth and expected weather and ice conditions and associated mobility requirements (CAPP 2006).

For this Project, the planned offshore exploration and/or appraisal wells may be drilled using either a harsh environment semi-submersible or drillship MODU (Figure 2.3).

Semi-submersible MODUs can either be towed to the drill site or move under their own power, and are designed for drilling in rougher seas. The main deck of the unit is supported by a series of vertical columns, which in turn sit atop steel pontoons that float below the water surface during operations. The pontoons are filled with water so that the unit floats with the main deck above water and the remainder below the surface, and the platform can be raised or lowered by adjusting the amount of ballast water they contain. Because much of the mass is below water, these units are relatively stable in rough seas. On site, these MODUs will either be moored to the bottom with a series of large anchors, or in deeper waters utilize a dynamic positioning system in which thrusters position the vessel and keep it steady (Figure 2.3).

Drill Ships are also typically used in areas of relatively deep water. These are ships which contain complete drilling systems and are almost entirely self-contained, making them able to operate at remote sites with limited support. Drill ships have a larger variable deck load (VDL) capacity so a relatively large amount of equipment and materials can be stored on board the ship. They can be anchored to the bottom in shallower water depths, but most commonly use dynamic positioning systems to maintain position at the well site, as well as to rotate the ship into prevailing weather to help minimize the pitch and roll motion. Drill ships typically have a derrick near the centre of the vessel hull that contains and operates the drilling equipment, where a moon pool provides access from the deck surface through the centre of the ship to the water surface (Figure 2.3).

Figure 2.3 Examples of Semi-submersible (*Top*) and Drill Ship (*Bottom*) MODUs



Source: Seadrill (2017): *http://www.seadrill.com/media-centre/image-library/our-rigs/west-aquarius.aspx*



Source: Stena Drilling (2017): *http://www.stena-drilling.com/fleet-availability/stena-carron*

The overall purpose of a MODU is to provide a stable and safe supporting infrastructure at the well site in order to house and operate the drilling equipment (Amec 2014). Table 2.4 provides a general overview of the key components and equipment that will be associated with the MODU.

Table 2.4 Typical MODU Components and Equipment

Permanent Equipment	Purpose
Subsea Equipment	Includes well control equipment such as blowout preventers (BOP), marine riser, and control system. BOPs are devices used to seal and control the release of formation fluids. They are installed on the wellhead, located just above the mudline. The riser acts as a conduit from the BOP to the MODU.
Ballast Control	Used to maintain MODU stability during operations.
Station Keeping	Dynamic positioning (DP) maintains the position of the MODU under a range of environmental conditions. DP systems consist of thrusters (propellers) and sensors to monitor the weather conditions and MODU position. Thrusters are automatically controlled by the DP system. As well, MODUs have a mooring system comprised of anchors, chain / lines, and winches.
Derrick	Support structure to contain the drilling rotating equipment and move the drill string in and out of the wellbore.
Drilling Package	Includes top drive, drawworks, rotary table, heave compensator, and tubular make up/handling equipment.
Power Generation	Diesel-driven engines and AC generators which are used to operate the equipment on board the MODU. Includes emergency power.
Helicopter Equipment	Heli deck for safe transfer of personnel and equipment. Includes refueling station.
Cranes	To transfer equipment between MODU and supply vessels and to move equipment safely around the MODU. Includes pedestal / revolving type and monorail overhead cranes.
Storage	Provides areas to house drilling equipment and materials. Includes bulk storage of liquids including drill water, synthetic base fluid, drilling fluid, fuel and solids such as bentonite, barite, and cement.
Waste Management Facilities	Enables offshore treatment or temporary storage of waste prior to treatment or shipment back to shore for processing.
Emergency Equipment	Includes firefighting equipment, lifeboats, and rafts.
Solids Control / Fluids	Includes mud pumps, shale shakers, and high pressure pipework circulating system.
Accommodation	Includes berths, bathrooms, water supply / storage and/or processing water system and mess facilities for up to 200 personnel.

MODUs and their associated equipment allow for the raising and lowering of the drill pipe and drill bit, the movement (rotation) of the drill bit, and the circulation of drilling fluids. Each of the types of MODUs identified above are essentially self-contained, provide access to the ocean surface and water column to facilitate drilling into the seabed, and include the above noted drilling equipment. MODUs also contain associated support infrastructure and facilities such as transportation facilities (for helicopters and supply vessels), work areas, safety equipment and crew accommodations.

For this Project, the specific type(s) of MODU eventually selected for use must be capable of drilling at any time of the year in the weather and oceanographic conditions and water depths that are present in the Flemish Pass area in general, and within ELs 1144 and 1150 in particular. The specific characteristics of MODUs used for this Project may vary depending on the specific well sites identified

and other factors. It is also possible that there may at times be two different MODUs operating in different parts of the Project Area simultaneously as part of the Project. Any MODU proposed to be operated off Newfoundland and Labrador must also first be evaluated and granted a Certificate of Fitness issued by a certifying authority in accordance with requirements of the Accord Acts.

2.5.2 Planned Project Activities

The Project may involve the drilling of up to 10 wells within the two ELs that comprise the Project Area over its temporal duration. Particular wellsite locations are not currently defined, and will be selected as Project planning and design activities move forward. Similarly, specific well designs have not yet been completed by Nexen, and these will require consideration of a variety of factors, including well location (both surface and bottom-hole), water depth, subsurface geological properties, total well depth, evaluation requirements, and other factors. Detailed, individual well designs will therefore be developed for each drillable prospect as Project planning and implementation progress, and will be submitted for approval to the C-NLOPB as required per the OA and ADW application and approval processes described earlier in Section 1.5.

2.5.2.1 MODU Mobilization

Pending receipt of all required regulatory approvals for the Project (and for each individual drilling campaign within it), as well as the completion of the various associated corporate planning, procurement and approval processes required, the selected MODU will be mobilized to the planned drilling location. In preparation for MODU arrival at the well location, positioning transponders may be placed on the seabed and met ocean equipment (wave rider and current meters) may be deployed.

Prior to the start of drilling, a seabed investigation will be conducted. This seabed investigation would typically be conducted using a ROV, sonar (multi-beam or side scan) or other relevant equipment, which is deployed from the MODU or a support vessel for a visual inspection of the seabed prior to initiating drilling activities.

Throughout the duration of an offshore drilling program in the Canada-NL Offshore Area, other marine vessel traffic is restricted within a defined area surrounding the MODU as a safety precaution. As specified in the *Newfoundland Offshore Petroleum Drilling and Production Regulations*, this safety zone is usually the greater of either the area within a 500 m radius of the MODU or, if the unit is anchored, a zone 50 m from the anchor pattern as per the requirements of the *Collision Regulations* under the *Canada Shipping Act, 2001*. The safety zone is established for the protection of the MODU as well as other ocean uses, and especially, to prevent direct interactions between the MODU and its associated equipment and other marine vessels and activities. The safety zone is monitored by a standby vessel, and Notices to Mariners and other measures are also used to continuously communicate the presence and nature of these drilling activities and associated safety zones to other vessels and marine operations in the area (see Chapter 13).

2.5.2.2 Offshore Well Drilling

Once the MODU is mobilized and in place and all of the above described preparatory activities have been completed, the offshore exploration well will then be progressively drilled in sections over a period of up to several months. In each drilled section, the well bore is gradually reduced in size. After each

section is drilled, steel pipe or casing is installed and cemented into place to stabilize the well bore, isolate pressure/fluids and prevent drilling fluid losses prior to drilling ahead with the next hole section, according to the general sequence summarized below:

1) *Riserless Hole Sections:* For the first two to three hole sections, there is no closed loop circulating system in place (no riser) so the drilling fluids and cuttings are circulated onto the seabed. Drilling fluid is used to cool the bit, maintain wellbore stability and transport the drilled cuttings to the seabed. Typically seawater and/or water-based mud (WBM) is used during the drilling of these riserless hole sections.

   The riserless hole sections are comprised of the following:

   a) The largest hole section, approximately one metre in diameter, is drilled to approximately 100 m below mud line (BML).

   b) The conductor casing and low pressure wellhead housing are installed on a landing string. The conductor casing is typically cemented into place. Generally, the top of cement is brought to the mudline. Sometimes a second conductor hole section is drilled below the conductor casing but this is not usually required in this region.

   c) Next, the surface hole section is drilled, generally to depths of approximately 700 to 1,000 m BML.

   d) The surface casing and high pressure wellhead housing are installed on a landing string. The surface casing is cemented into place. Generally, the top of cement is brought to the mudline.

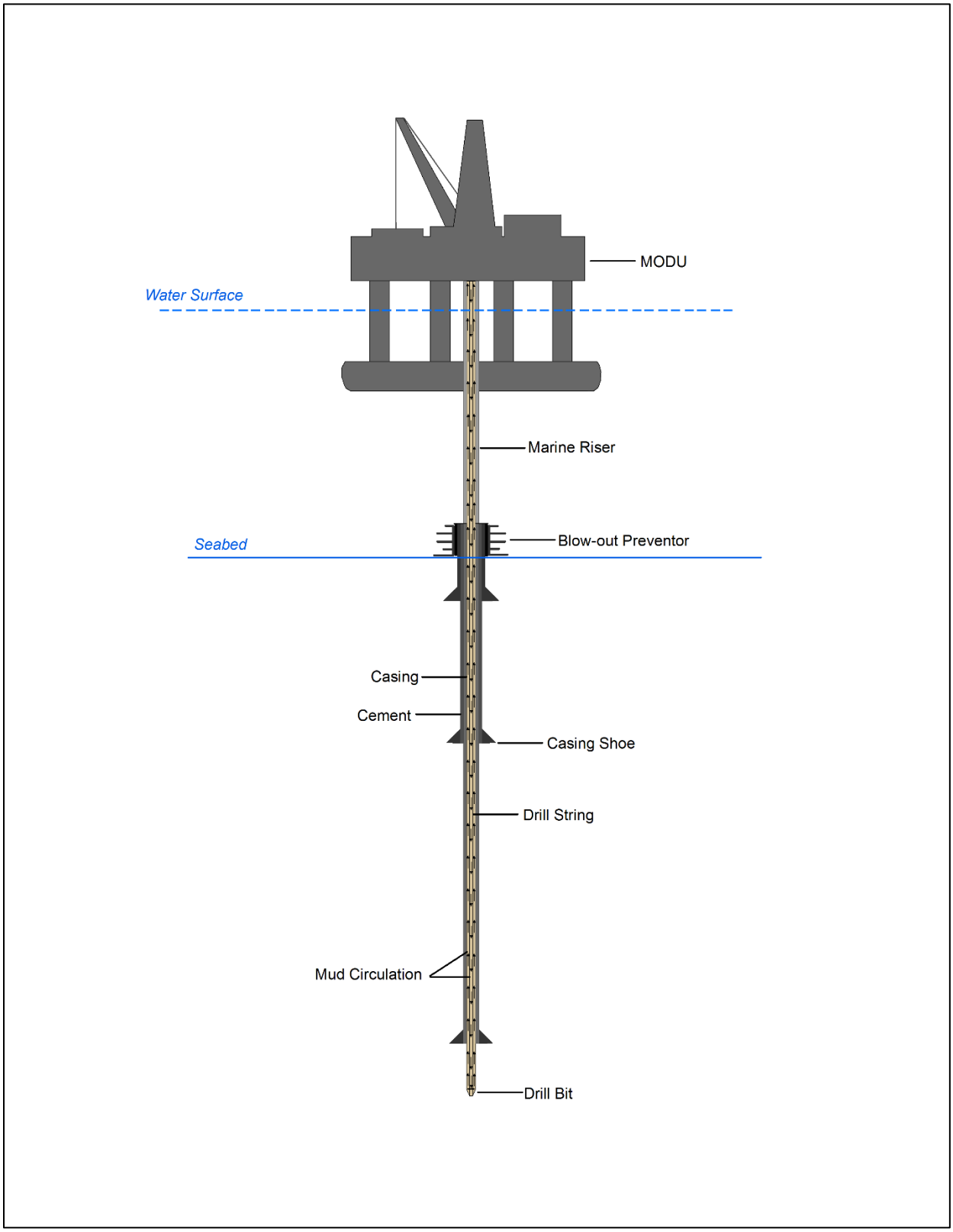
   e) The BOP is run on the marine riser pipe and is connected to the wellhead system, creating a closed system conduit between the MODU and the well. The BOP comprises a system of high pressure valves that prevent hydrocarbons from escaping into the environment in the event of an emergency or equipment failure during drilling.

2) *Riser Drilling:* Once the riser is installed, the remainder of the hole sections may be drilled with WBM or synthetic-based mud (SBM). The riser creates a conduit for the circulation of drilling fluids down the drill string, through the bottomhole assembly / drill bit, back up the open hole / casing annulus to the riser annulus and back to the MODU. Drilled cuttings are also transported back up the annulus to the MODU for processing. At various intervals, depending on pore pressure, formation fracture gradient and presence of geohazards, intermediate casing strings or liners are installed and cemented in place as part of ensuring safe well operations.

Drill cuttings and drilling fluid use, treatment and eventual disposal are discussed further in a later section of this chapter.

Figure 2.4 provides a generalized schematic of a typical offshore well. For the planned exploration drilling activities being undertaken as part of this Project there will be no excavated drill centers and no required underwater construction activities.

Figure 2.4 Conceptual Diagram of a Typical Offshore Exploration / Appraisal Well



NOTE: For general illustration only, MODU and well components not to scale.
Additional intermediate casing strings / liners may be installed, depending on well specific conditions and detailed well design

In addition to the somewhat more traditional approach of mobilizing the MODU to a well location and fully completing that well before moving on to the next, the Project may also include "batch drilling" activity, in which the riserless sections for multiple wellsites are initially and consecutively drilled, after which the MODU returns to these sites to complete the remaining portion of the wells.

2.5.2.3 Vertical Seismic Profiling

VSP (which is also at times referred to as a "check-shot" survey) will also be conducted at individual well sites as required throughout the temporal scope of this Project. VSP is a technique that is used to further define the characteristics and depth of identified geological features and potential petroleum reserves by obtaining high resolution images of the target. Specifically, these surveys are often undertaken following completion of drilling to obtain accurate time-to-depth ties to correlate seismic data to well depth.

If required, a VSP survey will be undertaken by placing a string of receiver (geophones) down the well at pre-determined depths, with a seismic source (usually mid-sized sound source arrays) suspended from the MODU. Walk-away VSP surveys may also be undertaken, which involve placing a sound source on a vessel which then moves away from the MODU while activating the seismic source at pre-determined distances from the borehole receiver. The check-shots are recorded at multiple intervals down the well, and the resulting information assists in determining and confirming the depth of the drilled well and for reconciling drilling information with that obtained through seismic survey work. VSP surveys are typically short-term activities (usually one to two days duration), with seismic source activation often limited to just a few hours.

VSP surveys are somewhat similar to surface seismic surveys undertaken for offshore oil and gas exploration in that a sound source and a receiver (or hydrophone) is used to provide data that can be interpreted to delineate geological features and identify potential hydrocarbon accumulations. VSP differs, however, in that it is conducted in a vertical wellbore using hydrophones inside the wellbore and a sound source near the surface at or near the well. A VSP is also usually quieter and more localized than a surface seismic survey, with up to 10-12 individual smaller sound sources typically being used for VSP, each of which is generally placed several meters below the water surface. The overall nature and specific characteristics of any VSPs required and conducted for this Project will depend on various factors, including the individual well in question, the geological target being investigated, and the particular objectives and data requirements associated with the survey.

2.5.2.4 Well Testing

Wireline Logging

Petrophysical data will be acquired via wireline logging tools, provided by a third party contractor. These tools are used to record continuous measurements of the formation properties, including reservoir rock and fluids. The aim of wireline logging is to characterise the reservoir properties, in particular understanding the composition and heterogeneity of the reservoir and predicting the distribution of the porosity, permeability and saturation. Logging of formations takes the form of logging while drilling (LWD), in which logging sensors are placed just behind the drill bit, and openhole (wireline) logs using a logging tool. Various petrophysical parameters can be assessed during wireline logging, including electrical parameters (resistivity), neutron density, gamma, self-potential and density.

Well Flow Testing

If there is an indication of commercial hydrocarbons found during the drilling and evaluation of an exploration well, a well flow test may be conducted to sample and identify formation fluids (which may contain hydrocarbons and/or water) and to measure produced flow rates.

A well flow test generally involves the flowing of well fluids from the reservoir to gather additional information on the potential reservoir properties, such as productivity, volumes, fluid composition, flow rate, pressure and temperature, with the resulting information informing the evaluation of the potential commercial significance of the discovery. Testing can occur during the well drilling process or immediately thereafter, or possibly at some later date by re-entering a suspended well. Flow testing is required pursuant to the *Newfoundland Offshore Petroleum Drilling and Production Regulations*, prior to obtaining a Significant Discovery Licence (SDL) from the C-NLOPB.

During such testing, produced fluid is flowed back to the MODU, where hydrocarbons are separated from any produced water and samples are collected and analysed. A typical formation flow test involves perforating a casing that has been set across the hydrocarbon-bearing reservoir, after which reservoir fluids flow into and up the wellbore to the MODU where the well fluids are measured, analysed and possibly stored for future analysis. Produced hydrocarbons are flared using high-efficiency burners supplied by a third party. If there is a significant amount of produced water involved, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge.

Formation flow test would only be carried out as part of this Project on any wells where hydrocarbons are discovered and additional information on the specific characteristics of the discovery is therefore required. The duration of any such well testing is dependent upon various factors but is typically in the order of several days, although this may be of longer duration depending on the particular characteristics of the hydrocarbons found and the analysis being undertaken. If required as part of this Project, any associate flaring activities will be kept to a minimum. Alternative testing technologies, with the potential for improved safety and environmental performance, may also be proposed. A formation flow test may, for example, be carried out using a drill pipe conveyed test assembly. In such cases, the hydrocarbons are circulated to surface and recovered with only a small volume of produced water sent to a flare.

2.5.2.5 Well Abandonment or Suspension

Once drilling and any associated well testing is completed, offshore wells are typically then abandoned permanently, or in some cases, suspended. The final well abandonment requirements and approach for the Project have not been finalized, but will adhere to the requirements set out under the *Newfoundland Offshore Petroleum Drilling and Production Regulations*, as well as Nexen's internal governance.

Abandonment or suspension involves the isolation of the well bore by placing cement plugs, potentially in combination with mechanical devices, at various depths. If removal of the equipment extending above the mudline is required, the casing will be cut just below the mudline and upper sections of casing and the wellhead will be recovered to the surface. This may be done immediately after the well is drilled and evaluated using the MODU or sometime after the well is suspended using a vessel. An ROV or other equipment is then used to inspect the seabed to ensure that no equipment or obstructions remain in

place. Alternatively, approval may be sought to leave the wellhead in place on the seabed. In this case, wellhead position would be reported with Canadian Hydrographic Services so nautical charts can be updated.

Decisions regarding the specific approach and methods to be used for the abandonment of individual wells drilled as part of this Project will be made on a well-specific basis, in consideration of available technology, water depth, well casing design, presence of reservoirs and hydrocarbons, quality / top of annular cement behind casing strings, and potential future well operations, as well as previous experience removing wellheads in similar conditions. In some circumstances, a well may not be abandoned permanently but rather suspended for future re-entry. In such cases, the same activities as those described above would be undertaken in ensuring isolation of all hydrocarbon-bearing intervals, but the casing / wellhead would be left in place for future use.

Well abandonment or suspension for this Project will be carried out as per Nexen's internal requirements and procedures, as well as applicable industry practice and in compliance with relevant regulatory requirements. These activities will adhere to the requirements set out under the *Newfoundland Offshore Petroleum Drilling and Production Regulations*. In the event that planned, conventional well abandonment techniques such as those described above are ineffective for a particular well, alternative approaches may be required and will be investigated and implemented in consultation with relevant regulatory authorities and in compliance with applicable authorizations. Wells will be monitored and inspected in accordance with applicable regulatory requirements at the time of abandonment.

2.5.2.6 Supply and Servicing

The planned offshore exploration activities being proposed as part of this Project will be supported by a number of logistical and supporting activities, including an existing onshore supply base, offshore supply vessels and aircraft as required.

Onshore Supply Base

A supply base provides re-fueling, temporary storage, staging and loading of materials and supplies to support offshore exploration activities. One or more existing facilities in Eastern Newfoundland are expected to be utilized for these purposes for this Project. Aircraft support for the Project will be based at St. John's International Airport, as described below.

These existing shore-based facilities are owned and operated by independent third party service providers which service multiple operators and their activities, and were developed and operate in accordance with relevant regulatory requirements and approvals. Third party services and support for this Project will be procured through a competitive bid process in accordance with the requirements of the Accord Acts. The Project will not require or result in any Nexen owned / operated or otherwise controlled facilities being developed or used, nor any Project-specific infrastructure modifications or expansions at these established shore base facilities. The infrastructure and overall activities associated with the operation of these existing shore-based facilities are therefore not part of the scope of this Project.

Supply Vessels

Marine vessels are used to transport personnel, equipment and other materials to and from a MODU during an offshore exploration program. Supply vessels will make regular trips to the MODU throughout the program, and a dedicated stand-by vessel will attend to the MODU throughout the drilling campaign. Personnel will be transported to and from the MODU by helicopter or supply vessel (see below). These services will again be procured from existing, established third party suppliers that service the offshore oil and gas sector.

Supply vessels that are involved in Project activities will travel directly between an established port facility in Eastern Newfoundland and the MODU operating within an EL in the Project Area, a practice which is common in the oil and gas industry that has been active in this region for several decades. Figure 2.5 illustrates a potential traffic route to ELs 1144 and 1150 that may be used for this Project and associated distances. This information is provided for general information and illustrative purposes, recognizing that specific routes may vary at times based on the particular location of the active MODU(s) and the particular onshore facility being used, environmental conditions (including weather and ice), and other logistical factors.

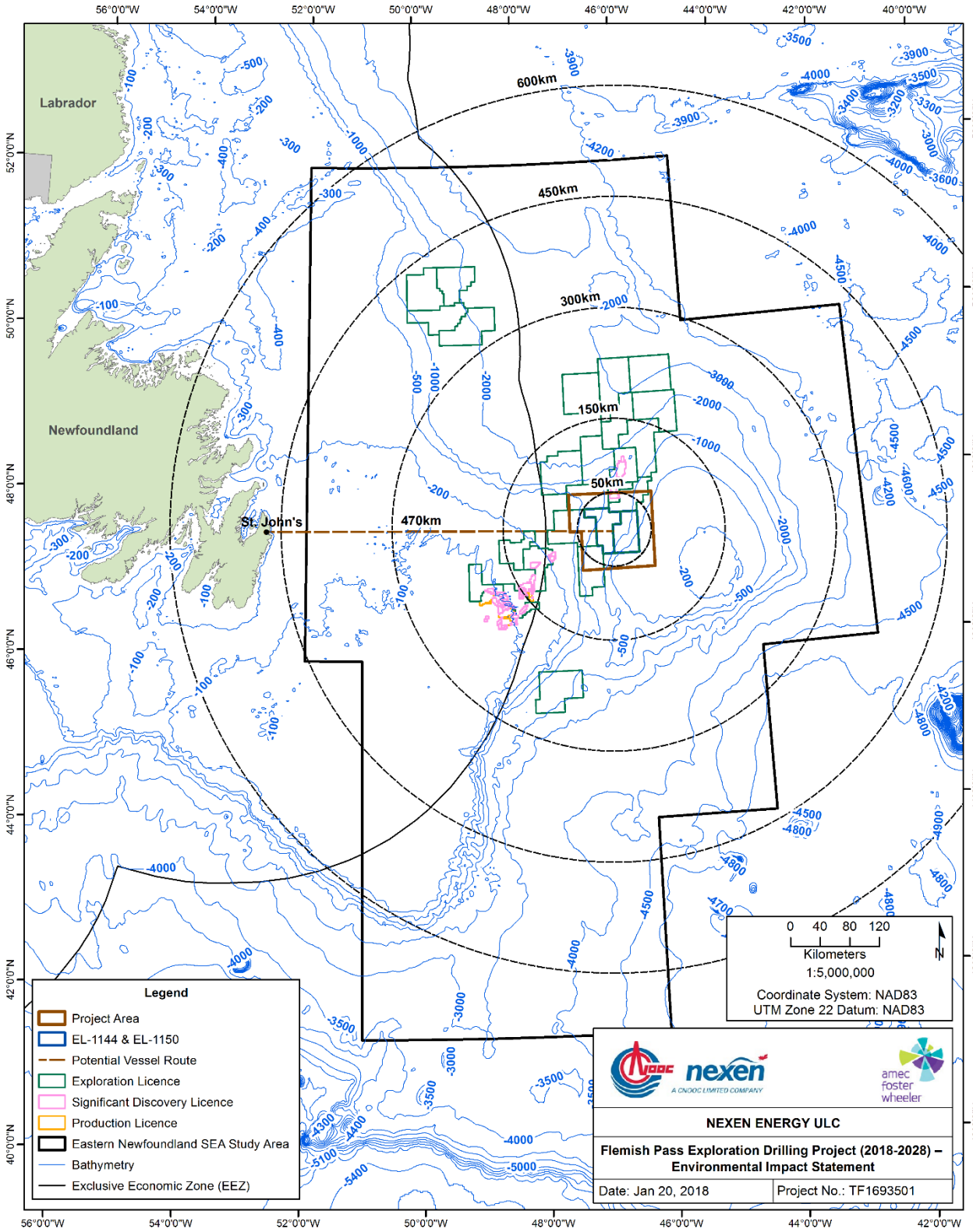
It is anticipated that with a single operating MODU there will be two to three return transits per week by the supply vessels during the course of the Project. In the case that two MODUs are operating at the same time, the number of vessel transits could increase to between four to five trips (or more) per week. All MODUs and vessels that are used for this Project will meet the operational and environmental capabilities needed for the associated exploration and support activities, including for implementing relevant environmental mitigations and safety and emergency response procedures. All vessels will be in compliance with applicable legislation and regulations, and will be inspected by Transport Canada and approved for operation by the C-NLOPB before beginning any Project-related work. They will have appropriate oil spill / pollution prevention and emergency response plans in place, and each will be MARPOL compliant.

Aircraft

Helicopters will also be used for the transportation of personnel and key materials to and from the MODU(s) as required throughout the course of the Project. Aircraft support will be supplied by a third party licensed operator under contract to Nexen, and is expected to be based at an existing facility at St. John’s International Airport. Nexen is again not planning to construct or operate a helicopter base as part of this Project, and it will not require or result in any Project-specific infrastructure modifications or expansions at any established aircraft facilities.

It is estimated that there would be one to three helicopter transits per day to the MODU, which would increase proportionally in the event that two MODUs are being used simultaneously (i.e. to two to six transits per day). Helicopter traffic to and from the offshore area is, however, weather dependent, and it is therefore anticipated that flights will not occur every day due to weather conditions or other technical matters. Aviation is regulated by Transport Canada, including various applicable regulations and operational requirements for helicopter flight traffic. The C-NLOPB has also established and enforced specific operational and regulatory requirements for flight traffic associated with offshore oil and gas exploration and development activities.

Figure 2.5 Potential Vessel and Aircraft Traffic Route



2.6 Project Personnel

The various exploration activities associated with the Project will be overseen by Nexen's multidisciplinary team based in its St. John's, NL office, with support from Nexen's offices and staff in Calgary and elsewhere as required.

The onshore Nexen team will work with the Drilling Contractor's onshore team which includes an Operations Manager, MODU Manager, and Health, Safety and Environment (HSE) Advisor. The Nexen offshore team will include Drilling Supervisors, Wellsite Drilling Engineers, Wellsite Geologists, Well Site Logistics Coordinators, and Wellsite HSE Coaches. During operations, the offshore team will be led by the Nexen Senior Drilling Supervisor who is responsible for the overall execution of the drilling program and providing supervision of the operations at the wellsite. The Senior Drilling Supervisor also liaises with the drilling contractor's offshore leadership team including the Offshore Installation Manager (OIM) and Senior Tool Pusher. The Senior Drilling Supervisor reports to the onshore Drilling Superintendent.

Nexen will also retain contractors and subcontractors for the provision of particular services and deliverables associated with the Project, including the supply, mobilization and operation of the MODU(s), onshore supply base support, supply vessels and aircraft, and the supply of other required products and services. The number of personnel on the MODU during offshore operations will likely range from approximately 100 to 200 persons. Onshore personnel will support the Project as required.

2.7 Project Schedule

As described in Section 1.3.2, ELs issued by the C-NLOPB have a maximum nine year term (consisting of two consecutive periods), where the interest owner is required to drill or spud and diligently pursue one exploratory well on or before the expiry date of Period I as a condition of obtaining tenure to Period II. The planned temporal scope of this Project (2018 to 2028), has been defined so as to address the terms of the ELs 1144 and 1150 - within which regulatory approvals must be obtained and drilling planned and commenced within that timeframe - as well as to allow for the associated stages of well drilling, testing, and abandonment or suspension as required. Figure 2.6 provides a generalized Project schedule, for illustrative purposes, indicating the potential staging and approximate durations of key project activities.

Detailed planning and procurement processes for the Project are on-going in 2018 and will continue throughout the life of the Project. Pending the receipt of applicable regulatory and corporate approvals, review of available seismic data and other information and the identification of suitable drilling targets and other technical, logistical and commercial considerations, in-field Project activity could commence as early as 2019. It is currently anticipated that up to 10 wells may be drilled as part of this Project, although this number, and the specific number per EL, may evolve as Project planning and implementation proceed. Within its temporal scope, each of the planned exploration activities that comprise this Project may occur in any year of the proposed exploration program, and at any time of the year.

It is expected that each offshore well will require approximately 45 to 160 days for drilling, evaluation (including sidetracking and potential well testing, if required) and well abandonment or suspension. There may at times be up to two MODUs working in different parts of the Project Area simultaneously.

Figure 2.6 Project Schedule (Illustration of Single Well in Multi-Well Program)

Event	Duration	1st year				2nd Year				3rd Year				4th Year			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Stakeholder engagement	Ongoing																
Regulatory approvals	2-3 years																
Well engineering, design and planning	1.5-2 years																
Pre drill site investigation and site preparation	5-20 days																
Drilling operations (single well including a well test)	45-160 days																
End of drilling reporting	1 year																
Evaluation of drilling results																	

The specific nature and timing of each Project phase and activity within each year of the program will continue to evolve and become further defined as planning and implementation progress. This will include the on-going analysis and interpretation of seismic data and other information, the nature and results of Project related exploration activities in previous years and their findings, and Nexen's specific exploration requirements, obligations and objectives.

In addition to the temporal aspects of the Project itself, the EIS also defines and considers temporal study boundaries for the assessment which include and encompass the overall timing of Project related activities in the offshore environment, but also the likely timing and duration of any resulting environmental interactions and effects. In conducting the environmental effects assessment, consideration is given to the relevant temporal characteristics of the affected environment, including the timing of presence of relevant environmental components (species and activities) within the defined EIS Study Areas, any particularly sensitive or critical periods, likely response and recovery times to potential environmental changes and effects, and any natural (without-Project) variation in the baseline environment. This is described further in Section 4.3 of the EIS.

2.8 On-Going and Future Project Planning

The consideration of environmental issues from the earliest stages of project planning and design and throughout eventual implementation is an integral and fully integrated part of Nexen's approach to its petroleum exploration programs and other activities.

As illustrated throughout this EIS, potential environmental issues and interactions that may be associated with the Project can be avoided or reduced through the use of good planning and sound operational practices and procedures, supported by standard mitigation measures that are well established and outlined in relevant regulatory procedures and guidelines, and which have been routinely and effectively applied to similar offshore exploration programs carried out in the Canada-NL Offshore Area and internationally for decades. For this Project, these standard mitigation measures will be implemented through and/or supplemented by Nexen-specific policies and procedures that have

been identified through this EIS, and through the various post-EA regulatory review processes that will apply to the Project (Sections 1.3 and 1.5). The Project will not likely result in significant adverse environmental effects due to the implementation of these environmental protection measures.

2.8.1 Project Design Changes as a Results of EA Findings

As noted throughout the EIS chapters that follow, the environmental analysis and various governmental, stakeholder and Indigenous engagement initiatives undertaken as part of the assessment have yielded a variety of useful and informative perspectives related to the Project and its potential environmental effects. These inputs have helped shape the nature and focus of the EIS, in terms of the selection of the various VCs upon which it has focused (Section 4.2), and the specific content and focus of the description of the existing environment (Chapters 5-7) and the environmental effects assessments (Chapters 8-17), including the particular environmental issues and interactions upon which it has focused and the associated identification of mitigation.

These initiatives did not, however, result in the identification or elaboration of new and previously unidentified environmental components or issues of concern, over and above those that are specified in the EIS Guidelines, and/or which were otherwise identified by the EIS Study Team in planning and completing the assessment. In addition, the nature of this exploration program itself means that - at the EA stage, in particular – the Project does not involve a detailed “design” and proposal of particular components, as a development project might. Rather, this Project is currently based on fairly standard and typical equipment and exploration methods, and will be undertaken in accordance with applicable regulatory requirements. This has meant that the Project description (Chapter 2) has not been subject to any specific “design changes’ as a result of the EIS, including the associated engagement initiatives and their outcomes.

Nexen will, however, continue to review these inputs and perspectives as the planning and eventual implementation of the Project progress, and will consider them in its Project-related planning and decision-making as applicable. Project implementation will also include on-going communication and cooperation mechanisms involving key organizations throughout its operational life, as discussed in this EIS. These are intended to allow for continued discussion of Project related activities and any issues as they may arise during its implementation, as well as to cooperatively and collaboratively plan and implement any required (adaptive) management measures throughout the life of the Project.

2.8.2 Project Planning, Assessment, and Implementation: Application of the Precautionary Principle

In planning and designing the Project and throughout the course of the EA - including the environmental effects analysis and the identification of mitigation included in this EIS – Nexen has applied a precautionary approach to assessing and attempting to avoid or reduce adverse environmental effects. This has included consideration of the precautionary principle, which was defined by the 1992 Rio Declaration on Environment and Development (Principle 15) as follows:

> *Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation.* (UNCED 1992).

As illustrated throughout the EIS, the Project does not require or propose the use of new or different equipment, methods or other technologies during its planned components and activities. It will use standard and proven exploration components and methods, for which potential environmental issues are well understood and fully manageable through existing and effective mitigation measures. Notwithstanding this, the application of a precautionary approach is reflected in a number of aspects of Project planning and design, and in the conduct of the EA reported herein. Some examples of this precautionary approach are provided below:

1) In many cases, the EIS environmental analysis, including the effects predictions and the planned application of mitigation, are quite conservative and therefore precautionary in nature. They inherently assume, for example, that an environmental component is present in the area and within the Project's environmental zone of influence, and therefore, is "available" for a Project-VC interaction. In reality, in many cases the abundance and spatial and temporal distributions and movements of the VCs limits the potential for interactions and effects with the Project's relatively short-term activities and localized disturbances.

2) Similarly, and in keeping with the spirit of the precautionary principle as defined above, many of the mitigation measures identified in the EIS are committed to and will be implemented even where it is not certain that a Project-related interaction and resulting effect will occur. For example, prior to the start of a drilling campaign, a seabed investigation will be undertaken to investigate the potential presence of coral colonies in the wellsite area. This seabed investigation and associated mitigation will be applied to all wells drilled as part of the Project, and not just those in any identified high potential areas for corals in the Project Area.

3) Also, for some key potential environmental issues, such as accidental events, the EIS has involved the completion and use of conservative environmental modelling and analysis, including in the associated oil spill modelling (Chapter 16), which is based on an "unmitigated" spill event. In reality, such a spill is both very unlikely to occur, and would be responded to immediately by Nexen through the various response plans and procedures described in this EIS.

In addition to Nexen-derived and implemented mitigation measures and precautionary approaches, an added layer of safety comes from the various post-EA regulatory review and planning processes that will apply to this exploration drilling program. The regulatory review and approval processes and other requirements that apply to oil and gas activities in the Canada-NL Offshore Area are amongst the most rigorous and stringent in the world, and operators are required to demonstrate that they have the ability and capacity to undertake such activities in a safe and environmentally responsible manner through various project deign measures, operational procedures, and response mechanisms. As part of its regulatory review and decision-making processes regarding drilling programs and other activities in this jurisdiction, for example, the C-NLOPB receives and considers information from operators that detail the proposed drilling locations and activities, the equipment and procedures involved, and the qualifications and training of personnel. The C-NLOPB's regulatory process requires, firstly, an authorization of the overall drilling program in the form of an OA, and secondly, a well approval in the form of an ADW for each well to be drilled.

2.9 Potential Environmental Emissions and Waste Management

Potential environmental emissions and discharges that may be associated with offshore exploration drilling programs include noise, light and other atmospheric emissions, liquid discharges, and other solid and liquid waste materials associated with the MODU and supply vessels and aircraft. The following sections provide a further overview of a number of environmental emissions, discharges and waste materials that may be generated over the course of planned Project activities, as well as a general description of how these will be managed.

There are a number of regulatory requirements that pertain to environmental emissions and waste materials associated with offshore exploration activities in this jurisdiction. These include various regulations under the Accord Acts which govern particular exploration or development activities and which include associated environmental protection requirements, as well as various Guidelines (some of which have been jointly developed with other agencies) that are intended to address specific environmental, health, safety and economic issues related to offshore petroleum exploration and production (see Section 1.5 for further details). Of particular relevance to this Project and its EIS are the:

- *Offshore Waste Treatment Guidelines* (OWTG),
- *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* (OCSG),
- *Environmental Protection Plan Guidelines*, and the
- *Drilling and Production Guidelines*.

The key regulatory guidance pertaining to emissions and offshore discharges, disposal and treatment for these types of offshore activities is contained in the OWTG, administered by the C-NLOPB. Other relevant guidelines and requirements that pertain to offshore waste discharges from such activities include the *International Convention for the Prevention of Pollution from Ships* (MARPOL) and others.

The OWTG provide performance targets for overboard discharges from drilling and production operations. In accordance with these Guidelines, and where applicable other standards and regulations, discharges from this Project will be treated before being released overboard. The Project's EPP, as required by the OA, will also provide details regarding the management of wastes, discharges and emissions for the drilling program. The EPP will be prepared in accordance with the above referenced *Environmental Protection Plan Guidelines* pursuant to the Drilling and Production Regulations. Chemicals used for drilling operations will be screened in accordance with Nexen's chemical management and selection process, and will adhere to the C-NLOPB requirements under the OCSG. The EPP will also include procedures and processes for handling, storage, transfer and disposal of all wastes during the Project, and a comprehensive Waste Management Plan similar to those used by the other Operators for comparable activities will also be developed and implemented for the Project.

In planning and conducting its oil and gas exploration activities, Nexen will comply with all relevant federal and provincial legislation, regulations and guidelines, as well as applicable international conventions and standards that apply directly to Project related environmental discharges and wastes. In terms of the former, these include the:

- Accord Acts and associated Regulations and Guidelines (as discussed above);

- *Fisheries Act*
- *Canadian Environmental Protection Act;*
- *Oceans Act;*
- *Navigation Protection Act;*
- *Transportation of Dangerous Goods Act*; and the
- *Canada Shipping Act.*

As described in Section 1.1, Nexen also has in place its own comprehensive environmental policies, plans and procedures for planning and conducting its oil and gas exploration and development activities, and requires its contractors to adhere to these as applicable.

2.9.1 Air Emissions

Atmospheric emissions resulting from planned Project activities will include exhaust from the MODU(s), supply vessels and aircraft and their associated equipment (such as on-board power generators), as well as emissions from the storage and flaring of hydrocarbons associated with well testing if and as required. The primary air emissions, including greenhouse gases (GHGs) (CO_2, CH_4, N_2O), that would result from these aspects of the Project include:

> *MODU, vessel and aircraft traffic*: CO, nitrogen oxides (NO_x), total particulate matter (TPM), PM_{10}, $PM_{2.5}$ SO_2, GHGs;
>
> *Power generation*: CO, NO_X, TPM, PM_{10}, $PM_{2.5}$, SO_2, GHGs.
> *Formation flow well testing*, which could include periods of flaring: CO, NO_X, V, TPM, PM_{10}, $PM_{2.5}$, SO_2, GHGs.

An estimate of the various air emissions that will be associated with the Project, by key component and activity, is provided in Chapter 14.

2.9.2 Drilling Wastes (Fluids, Cuttings, Cement)

Drilling fluids lubricate and cool the drill bit and hole, circulate cuttings and carry them back to the surface, and help to maintain appropriate hydrostatic pressure in the well to overbalance formation pressure, thereby providing the primary barrier for well control. A number of types of drilling fluids are typically utilized for offshore wells off Newfoundland and Labrador, including WBMs and SBMs. Drilling solids (cuttings) are the particles of crushed rock produced from the grinding action of the drill bit as it penetrates subsurface formations, the particle size, mineralogy and chemistry of which depend on the geologic strata being penetrated (Neff et al 2000; Peralba et al 2010).

2.9.2.1 Drilling Fluid Types and Their Composition and Use

WBMs are comprised primarily of water, barite, and bentonite. Salt or fresh water is the carrier liquid for WBM, and barite (barium sulphate) is used to control fluid density, which helps balance formation pressures within the well. Bentonite clay is a viscosifier, which thickens the fluid to suspend and help carry drill cuttings to the surface. Other substances can also be added to the WBM to obtain the required drilling properties of the fluid based on well design, such as thinners, filtration control agents and lubrication agents. All components of WBMs used offshore Newfoundland and Labrador are screened

in accordance with the OCSG and are classified under the Offshore Chemical Notification System (OCNS) as substances which pose little or no risk to the environment (PLONOR). As described earlier in Section 2.5.2, the initial “riserless” sections of the well bore will be drilled using WBMs in which case the fluid and cuttings will be returned untreated to the seabed at the wellsite as permitted by, and in accordance with, the OWTG. Once the riserless sections are complete, spent / excess WBM may be discharged at the well site without additional treatment in accordance with the OWTG.

Once the conductor and surface hole sections are completed and the riser and BOP are installed, the deeper sections of the well bore are then typically drilled using SBMs, which are returned to the MODU via the riser. SBM is a non-aqueous fluid comprised of internal olefins, alpha olefins, polyalphaolefins, paraffins, esters or blends of these materials. As with WBM, agents are added to control density, viscosity, fluid loss, and emulsion stability. The base fluid in SBMs is either highly processed mineral oils or synthetic hydrocarbons. The most common synthetic hydrocarbons are linear alpha olephins (LAO), internal olefins (IO), esters or parafins (COOGER and Lee 2009). These SBMs are characterized by a minimal polycyclic aromatic hydrocarbons (PAH) concentration (less than 0.001 percent) and low aromatic content (less than 0.5 percent) (OGP 2003). The advantages of using SBMs is they provide wellbore stability and cooling effectiveness comparable to oil-based drilling muds (OBMs) while at the same time being characterized by a low toxicity (Neff et al 2000; COOGER & Lee 2009).

Due to the improved environmental performance of SBMs relative to OBMs they had initially been permitted for discharge to offshore waters until the regulatory decision by the Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) which allowed discharge of SBMs into the sea only in certain circumstances (Neff 2008). Consequently, during typical drilling operations a closed-loop recycling system recaptures used SBMs and drill cuttings when they come back to surface. The recycling systems use a series of screens, shale shakers and centrifuges to physically separate progressively smaller drill cuttings from the liquid fraction of SBMs and reduce waste of SBM fluid (OGP 2003; COOGER and Lee 2009). At each stage of mechanical separation, the liquid stream is diverted from the cuttings, reducing the volume of the drilling fluid on wet solids (OGP 2003).

In the Canada-NL Offshore Area, the OWTG specify that other than any residual base fluid retained on cuttings, no whole SBM is currently permitted to be discharged to the sea. SBM-associated drill cuttings may, however, be discharged at the drill site provided they are appropriately treated prior to discharge in accordance with proven and practicable best available technologies and practices. Therefore, once onboard the MODU, drill cuttings will be removed from the drilling fluids in successive separation stages using solids control equipment, as described above. Some fluids will be reconditioned and reused, while any spent SBM will be returned to shore for disposal. The current regulatory performance target for SBM oil on wet solids prior to discharges defined in the OWTG is less than or equal to 6.9 g / 100 g.

2.9.2.2 Composition and Toxicity of SBMs Used Offshore Newfoundland

SBMs are generally regarded to have low toxicity (Scholten et al 2000; COOGER & Lee 2009). The organic synthetic base fluid used by many offshore operators in Atlantic Canada is Petro-Canada Puredrill IA-35LV (COOGER & Lee 2009; Li et al 2009; DeBlois et al 2014a); which is composed of aliphatic hydrocarbons in the fuel range (C10–C21) and which contains no aromatic hydrocarbons (DeBlois et al 2014a). Moreover, Puredrill IA-35LV is rated as a Category E product (least hazardous) in the Offshore Chemical Notification Scheme (OCNS) (DeBlois et al 2014b). Additional information on this and other potential SBMs that may be used for the Project is provided in Appendix H.

Metals in drilling fluids are primarily trace impurities in barite, bentonite clay and/or the drill cuttings from the subsurface formation being penetrated (Neff 2008). As a result, heavy metals can accumulate in SBMs as they are used (COOGER and Lee 2009). However, these metals are most commonly in an insoluble form and have low toxicity to plants and animals and limited environmental mobility (as reviewed by Neff 2008). Furthermore, the ability of these metals to become more bioavailable depends on their dissolution from inclusions of nearly insoluble barite, which is controlled in part by accessibility of the metals to the water phase at the solid-water interface as well as the solubility of the metals themselves in seawater (Neff 2008). The potential for this process to occur may be further limited, as SBM-associated cuttings tend to clump and settle rapidly to the bottom near the discharge location (Neff et al 2000; Neff 2008), thereby minimizing the potential for exposure to surrounding biota overall.

For SBMs overall, their acute (immediate/short-term) toxicity is reported to be unlikely although data on chronic toxicity is somewhat more limited (as reviewed by Bakhtyar and Gagnon 2012; Gagnon and Bakhtyar 2013). However, a detailed risk assessment of PureDrill IA 35-LV was conducted using the PetroTox model which was developed to perform aquatic hazard assessments of petroleum substances based on the composition of their constituents. The model identifies ecologically relevant concentrations according to acute and chronic toxicity test data for constituents (Redman et al 2014a; 2014b; 2017; Redman and Parkerton 2015), below which biological effects would not be expected. The no-effects concentration obtained via PetroTox was 150 mg / kg, with a range of 115 to 190 mg / kg (Stantec 2013).

Laboratory examination of the toxicity of Puredrill IA-35LV SBM in particular has been assessed for both fresh and recycled drilling fluids in sediments before and after biodegradation. The microcosms used for toxicity analysis were assessed after 0, 30 and 90 days incubation using standardized Microtox Solid Phase Test (EPS 1/RM/42 Environment Canada 2002), and amphipod (*Eohaustorius estuarius*) bioassays (EPS 1/RM/35 Environment Canada 1998) (COOGER & Lee 2009). None of the samples (control or Puredrill IA-35LV SBM on cuttings) were toxic according to the Microtox assay (COOGER & Lee 2009). Although the amphipod assay showed all samples containing Puredrill IA-35LV SBM on cuttings to be toxic, this was suspected to be a consequence of the amphipods being confined in a test container undergoing high rates of rapid biodegradation of the original organic compounds into intermediate degradation analytes with greater bioavailability (COOGER & Lee 2009; Gagnon & Bakhtyar 2013).

The biodegradation and mineralization of SBMs with Puredrill IA-35LV as the active ingredient has also been examined using laboratory microcosm studies (miniature-scale ecosystems maintained under controlled conditions) (COOGER & Lee 2009; Li et al 2009). The aerobic biodegradation of fresh (unused) and recycled (used) SBMs provided by a North Atlantic offshore drilling operation was compared under two temperature regimes (5°C and 20°C). The rate of mineralization of Puredrill IA-35LV SBM in sediment was greater in the higher temperature treatment (20°C) compared to the lower one (5°C) as well as for sediment containing fresh (unused) SBM compared to used SBM. However, the rate of mineralization of the recycled SBMs was consistent between both temperature treatments (COOGER and Lee 2009). From these results it was inferred that the rate of degradation at seafloor temperatures on the Grand Banks (approximately 0°C) would likely be slower, however, bacteria adapted to cold temperatures may still carry out degradation of hydrocarbons (COOGER & Lee 2009).

2.9.2.3 Drill Fluids and Cuttings

Table 2.5 below provided a summary of the estimated drilling materials and discharges associated with typical (example) wells that will be drilled as part of this Project. Further information and discussion of the various parameters and assumptions used in developing these estimates, is provided in Appendix D (Drill Cuttings Modelling Report).

Table 2.5 Estimated Drill Fluid and Cuttings Discharge Volumes (For Illustration Only)

Open Hole Section (Hole Diameter in inches)	Casing OD Section length (m)	Casing ID Fluid Type	Cuttings Volume per hole	
			Metric ton (MT)	m^3
1,137 m Water Depth – Deepwater example well design				
Conductor (42”)	90	Seawater/WBM	280	150
Surface (26”)	750	Seawater/WBM	1000	460
Intermediate (17.5”)	1,280	SBM	735	310
Production (12.25”)	1,250	SBM	380	150
Sidetrack (12.25”)	1,250	SBM	380	150
Total WBM Cuttings Discharge			1280	610
Total SBM Cuttings Discharge			1495	610
WBM Cuttings Discharge Rate (per well section/per day)				
Conductor			280	150
Surface			455	209
SBM Cuttings Discharge Rate (per well section/per day)				
Intermediate			245	103
Production			76	30
Sidetrack			76	30
SBM retained on cuttings			6.9g/100g max	
TOTAL Cuttings Volume Discharge			2780	1220
378 m Water Depth – Shallow water example well design				
Conductor (42”)	90	Seawater/WBM	280	150
Surface (26”)	500	Seawater/WBM	550	250
Intermediate (17.5”)	740	SBM	430	180
Production (12.25”)	1230	SBM	390	150
Sidetrack (12.25”)	1230	SBM	390	150
Total WBM Cuttings Discharge			850	400
Total SBM Cuttings Discharge			1210	480
WBM Cuttings Discharge Rate (per well section/per day)				
Conductor			280	150
Surface			460	210
SBM Cuttings Discharge Rate (per well section/per day)				
Intermediate			432	90
Production			390	30

Open Hole Section (Hole Diameter in inches)	Casing OD Section length (m)	Casing ID Fluid Type	Cuttings Volume per hole	
			Metric ton (MT)	m^3
Sidetrack			390	30
SBM retained on cuttings			6.9g/100g max	
TOTAL Cuttings Volume Discharge			2060	880

Notes:

a) Both the Deepwater Example Well and the Shallow Water Example Well are examples only and actual wells could have different depths, hole sections and associated cuttings volumes. The Deepwater Example Well, the mudline is 1,168 m DFE (MODU floor elevation), MODU elevation above sea level is 31 m. For the Shallow Water Example Well, the mudline is 409 m DFE; depths are the bottom of the section relative to DFE, e.g., the conductor casing overall length is 90 m, running from 1,168 m to 1,258 m DFE.
b) WBM cuttings from conductor and surface sections released directly at the seabed: estimate 2 m above seabed allowing for some initial upward momentum as cuttings materials exit the well hole;
c) SBM cuttings from intermediate and production and sidetrack released from MODU, estimated 2 m below sea surface.
d) cuttings volumes are in situ with bulking and washout, and are reported per well, e.g., one EL 1144 well yields 1,220 m^3 of cuttings, one EL 1150 well yields 880 m^3 of cuttings
e) The above information includes a sidetrack following completion of the production hole as well as wireline logging, plugging and abandoning of the well and demobilization. While it is uncertain whether sidetracks will be part of the well plan or not, it is possible and a worst case in terms of amount of cuttings material per well. Therefore, to be conservative, sidetrack drilling and the associated cuttings discharge are included.

To provide additional, Project-specific information and analysis related to the nature and extent of drill fluid and associated cuttings disposition resulting from the Project, detailed drill cuttings dispersion modelling has been carried out for this EIS at two example well sites within the Project Area (one in each of ELs 1144 and 1150). This modelling was undertaken to evaluate the potential dispersion and eventual seabed "footprint" of these cuttings in various seasons (Amec Foster Wheeler 2017, see Appendix D). The results of this modelling are summarized in Section 8.3.4, and used to assess potential effects on benthic habitats and biota, particularly the overall habitat alternations that may be associated with this cuttings footprint (including its location, extent, and thickness) and the possible ecological implications of these.

2.9.2.4 Cement

Cement is pumped into the annulus between the casing and formations, and is used to secure the casing in place and isolate weak or hydrocarbon bearing formations. Drilled solids may also include hardened cement inside casing remaining from cementing the casing. Cement is also used to plug back the well to permanently abandon the borehole or to sidetrack to another bottom-hole location.

Prior to installation of the marine riser and BOP, any excess cement is discharged on the seabed surrounding the wellhead. Cement returned to the MODU once the riser is installed (which includes a waste stream of intermixed SBM, spacer, and cement) may be transported back to shore for treatment and or disposed of at an approved facility. Alternatively, approval may be sought to discharge excess cement slurry remaining after a cement job or larger cement volumes on an emergency basis arising from equipment problems. During commissioning, testing and cleaning of a cement unit, small volumes (approximately 1.0 m^3) of cement may be discharged into the sea (Table 2.6).

Table 2.6 Estimated Cement Use and Potential Discharges

Operation	Cement Discharges (m^3)	Discharge Location
Cement Spacer (diluted cement)	10 (conductor and surface casing)	Seabed
Conductor cementing	5 to 50	Seabed
Surface Casing Cementing	5 to 150	Seabed
BOP connected cementing		
Testing and Commissioning of cement unit	5 to 15	Surface
Cement unit cleanup post cementing operations	~1 per cementing operations	Surface

2.9.3 BOP Fluid Discharges

BOP control fluid is a water based hydraulic fluid specifically designed for operating the functions of the subsea BOP system. These water based fluids are designed to be an environmentally acceptable alternative to oil based hydraulic fluid. BOP control fluid generally consists of glycol, erifon and fresh water and has the following features: acceptable for discharge in the marine environment, anti-wear lubrication, resist microbial (bacterial/fungal) contamination, resist corrosion and maintain its effectiveness with seawater contamination.

Through the standard operation, pressure testing and maintenance of a subsea BOP, BOP control fluid will be vented to the environment (Table 2.7); these discharges are in compliance with the current waste treatment guidelines. While drilling offshore there may be planned and unplanned disconnect events (e.g. severe weather) where the MODU will secure the well and disconnect the lower marine riser package (LMRP) from the BOP stack resulting in the draining of the BOP conduit lines to the environment.

Monoethylene glycol is used subsea to inhibit hydrates from building up within the BOP connectors, which would prevent the BOP from properly disconnecting from the wellhead. ROVs are used to inject monoethylene glycol on a routine basis to eliminate any hydrates if present or to proactively prevent hydrates from forming.

Table 2.7 Estimated BOP Control Fluid Use and Potential Discharges

Operation	BOP Control Fluid Discharge (m^3)	Discharge Fluid	Discharge Location
Initial BOP control line flushing and function testing with ROV	Approximately 3 / BOP or LMRP latch event	BOP Control Fluid	Seabed
BOP testing	Approximately 30 / month	BOP control Fluid	Seabed
BOP disconnect (weather related or non-routine event)	Approximately 40 / event	BOP Control Fluid	Seabed
BOP function testing	Approximately 0.5 / week	BOP Control Fluid	Seabed
ROV injection into BOP connector (hydrate inhibition)	Approximately 0.3 / week	Monoethylene Glycol	Seabed

2.9.4 Other Liquid and Solid Waste Materials

A number of other wastes will be generated by the planned Project activities. Allowable chemical properties for offshore disposal of such materials to the marine environment and associated reporting requirements are also specified in the OWTG and other industry and regulatory guidelines and standards (see Table 1.2). Any liquid discharges that do not meet the applicable standards for ocean disposal will be transported back to shore for disposal at an existing and approved facility. Some of the known or potential liquid waste streams that may be associated with planned Project activities include those listed and summarized below.

Produced Water: Produced water is water that is trapped in underground formations which is sometimes brought to the surface during oil and gas exploration and production. If hydrocarbons are present and well testing is conducted, produced water may be encountered. The typically small amounts of produced water generated during exploration drilling are flared along with the produced hydrocarbons. Any large amounts of produced water may be treated to comply with the OWTG and disposed of offshore. The amount of produced water potentially encountered during exploration drilling is typically very small compared to that during production operations.

Bilge Water and Deck Drainage: Bilge water is seawater that does not drain off of and away from an offshore platform or ship but rather enters parts of the MODU or vessel and comes into contact with its various components and equipment as it does so. Deck drainage is seawater that comes into contact with the surface components of the MODU or vessel as a result of wave action, sea spray or precipitation and through planned activities (such as wash down). As bilge and deck drainage water can come into contact with equipment and machinery, it may become contaminated with hydrocarbons or other materials. Potential environmental emissions such as the release of oily water and discharges from deck drainage, bilge water, fire control system water, and others will be managed through strict adherence to applicable regulations and standards. This will include the installation and use of oily water separators to treat contained drainage, with treated water discharged in accordance with the OWTG.

Ballast Water: The term ballast refers to any material that is brought on board a vessel to enhance its stability and balance. For most steel-hulled vessels with appropriate technology, seawater is used for this purpose. Ballast water is stored in dedicated tanks on the MODU or vessel and therefore does not usually become contaminated through direct contact with equipment and other materials onboard. This practice may, however (depending on the recent sailing history of the vessel and its operational practices) raise concerns around the introduction and spread of invasive species. Ballast water will be managed and discharged in accordance with the International Maritime Organization (IMO) *Ballast Water Management Regulations*, Transport Canada's *Ballast Water Control and Management Regulations* and the OWTG.

Grey / Black Water: Liquid waste materials that will be generated by the crew onboard the MODU or vessels during the Project include grey water, which will include wastewater from washing, bathing, laundry and food preparation, as well as black water, or human waste (sewage). These discharges will be similar in nature and quantity to those associated with any offshore vessel, and will adhere to all applicable regulations. As a best practice, only environmentally friendly products will be used onboard the MODUs and vessels wherever possible. Black water (sewage) will be processed through the sewage treatment plants onboard the rigs and vessels and disposed of in accordance with the OWTG and MARPOL Grey water will be discharged at sea as far as practical from the nearest land. Galley

food waste will be processed and discharged from the rigs and vessels in compliance with the requirements of MARPOL. Any such wastes that do not meet the performance, sampling and analysis targets set out in the OWTG will be stored and transported to shore for disposal at an approved facility.

Cooling Water: Water cooling will be used as a method of heat removal from equipment onboard the MODU. Seawater is pumped onto the MODU and passed over or through relevant equipment to aid the cooling process. This water may initially be treated with biocides or through electrolysis to prevent microbiotic contamination issues. These will be selected and used in accordance with Nexen's chemical selection and management systems and the OCSG, and will be discharged in accordance with the OWTG. Cooling water is generally not treated for hydrocarbon contamination before it is discharged unless it is used to cool the drilling fluid pumps, in which case it is processed via the oily water separator ahead of discharge. Although the use and eventual disposal of seawater for cooling purposes results in water being discharged into the marine environment that is warmer than the receiving waters, this heat will be quickly dissipated.

Non-Routine Operational Liquid Discharges: Well testing will involve displacement of SBM from the well to a completion brine. This will involve the circulation of series of well clean-up chemicals, all which have the potential to be contaminated with SBM. These chemicals will be captured at surface, shipped to shore, and disposed of appropriately. In addition, a well test could involve an acid stimulation. All spent acid would be captured at surface and shipped to shore for disposal.

Water management systems and procedures for the Project will handle a number of water and waste water streams, including those associated with potable water, produced water, bilge and deck drainage water, ballast water, grey / black water (sewage), cooling water and others. The specific nature of the water management systems used during Project activities will depend on the specific MODU(s) selected and used, and the particular characteristics and configuration of the water management system in place on the platform.

Solid waste materials will be generated primarily by Project-related personnel housed at accommodations on-board the MODU and supporting vessels. All solid and domestic waste will be collected in dedicated waste receptacles and disposed of on a regular basis, with materials being separated and recycled where possible. Solid wastes that are intended for disposal will be stored in dedicated waste containers that will be transported to shore and collected by an approved waste contractor for transportation to an existing and approved waste disposal facility. Hazardous waste materials that may be generated during Project activities include spent and waste chemicals, chemical containers, spent absorbents and oily rags, batteries and biomedical waste. These will be stored in dedicated and appropriate waste receptacles for transportation to shore and eventual disposal at an approved waste management facility. Any hazardous wastes that are considered "dangerous goods" will be stored in appropriate containers and transported in accordance with the *Transportation of Dangerous Goods Act* and regulations.

Nexen is committed to the establishment of safe and environmentally responsible procedures for the generation, storage, handling, transportation, treatment and disposal of all waste materials generated throughout the course of this Project. Nexen will reduce, reuse and recycle liquid and solid waste and reduce liquid and atmospheric emissions to the extent practicable and in compliance with applicable regulations. All onshore and offshore waste discharges will be managed and disposed of as per the

Project's Environmental Protection Plan, Offshore Chemical Management Plan and the Waste Management Plan. Waste types and volumes will be documented as per relevant requirements.

2.9.5 Sound Emissions

Noise emissions into the atmospheric environment that are typically associated with an offshore exploration program include those resulting from the use of equipment on-board the MODU (eg, generators, thrusters, compressors and other working machinery) as well as from vessel and aircraft traffic. Although the operation of the MODUs, supply vessels and aircraft and other activities being planned as part of this Project will generate sound above water, atmospheric sound is not of particular concern given the localized and short term nature of these emissions, and due to the distance between the Project Area and any community or other human receptors. While any supply vessels and aircraft will originate on or near land (and therefore potentially in proximity to human components and activities), these activities will occur within areas and at existing facilities that are already subject to these activities, such as St. John's Airport and the existing industrial port facilities in Eastern Newfoundland.

Underwater sound will also be generated as a result of the planned Project activities. Noise emissions associated with an offshore drilling program include those associated with drilling itself, as well with the MODU's positioning systems, supply vessel traffic and other activities. Underwater noise will also be generated as a result of the sound energy from the source array for any associated VSP data collection (Appendix E). As described in Section 2.5.2, a VSP survey is quieter and more localized than a surface seismic survey. The nature and specific characteristics of any VSPs required and conducted for this Project will depend on various factors.

A further description of underwater sound that may be generated as part of the Project and its anticipated levels, duration and propagation through the marine environment is provided in Appendix E.

2.9.6 Heat and Light Emissions

Heat emissions from the MODUs and other Project components, such as those generated by engines and flaring, will be dissipated to the atmosphere without any anticipated environmental interactions or effects.

On-board lighting will be required for all Project activities that occur at night, and this must be in place and activated for safety and regulatory compliance reasons. Light emissions from the MODUs will include platform lighting, as well as those which may be associated with any flaring that is required during well testing operations. Light will also be generated by the supply vessels for navigation and deck lighting purposes, which will be comparable in nature and intensity to that from any other marine vessels operating off Eastern Newfoundland such as a large fishing boat. Lighting will be kept to a minimum to the extent that it does not affect crew and vessel safety. Flaring activity during a formation flow test will generate light and thermal emissions, but as described in Section 2.5.2 this will be an infrequent and relatively short-term (several days duration) activity.

2.10 Alternative Means of Carrying Out the Project

As an important and valuable planning tool, EA is intended to help inform and influence project design, and in doing so, to help proactively address the potential environmental outcomes of proposed development activities. The EA process therefore allows for the identification, analysis and evaluation of potential alternative project concepts and approaches, in order to incorporate environmental considerations into project planning at an early stage.

Section 19(1)(g) of CEAA 2012 requires that every assessment of a designated project take into account alternative means of carrying out the project that are considered technically and economically feasible, and consider the environmental effects of any such alternative means. Consistent with the CEAA Operational Policy Statement - Addressing "Purpose of" and "Alternative Means" under CEAA 2012 (Canadian Environmental Assessment Agency 2013) and the EIS Guidelines, the process for identifying and assessing alternative means of carrying out the Project has included the following steps:

- Identification of alternative means of carrying out the Project;
- Consideration of the environmental effects of alternative means are deemed to be technically and economically feasible;
- Selection of the preferred alternative means of carrying out the Project, based on the relative consideration of effect; and
- Assessment of environmental effects of the preferred alternative.

The following provides a discussion and analysis of various identified and relevant alternatives by Project component and/or activity. In doing so, it considers environmental, technical and/or economic factors, both in terms of the potential pros and cons of each identified alternative, as well as, where applicable, highlighting the rationale for the proposed option(s) that are the focus of the environmental effects assessments presented in this EIS (Chapters 8 to 14).

As part of Project planning and design, and as specified in the EIS Guidelines, alternatives were identified and evaluated for the following aspects of the Project:

1) Drilling Fluids Selection;
2) MODU Selection;
3) Drilling Waste Management;
4) Water Management and Location of Final Effluent Discharge Points;
5) Offshore Lighting;
6) Well Testing – Nighttime Flaring; and
7) Chemical Selection

These evaluations were completed early in the Project planning stages (and in this EIS) to allow for a focused and thorough assessment of a feasible Project. Although, in terms of overall EIS structure, this discussion is presented after the detailed description of the Project's planned components and activities which are outlined in the preceding sections, it should be noted that the evaluation of alternatives has taken place at a very early, iterative and fully integrated stage of Project planning. It is presented near

the end of this chapter, however, as this evaluation is dependent on much of the background information and details presented earlier in the detailed description of the Project's various planned components and activities.

2.10.1 Drilling Fluids Selection

Several types of drilling fluids are utilized for offshore wells off Newfoundland and Labrador, including WBMs and SBMs. As described earlier in Section 2.5.2, the initial drilling phases of an offshore exploration or appraisal well typically use WBM, the primary component of which is seawater, with other additives and approved chemicals also added as required to control and achieve the required fluid properties. As the first two to three hole sections of a well are drilled without a riser in place, the drilling fluids and cuttings that are used in and result from these initial drilling activities are typically discharged directly to the seabed. Under the OWTG, WBMs may be discharged at the wellsite where these meet applicable guidelines and other regulatory requirements. SBMs are then typically used in drilling deeper hole sections if the use of water-based fluids is technically impractical. SBMs were developed to replace oil-based fluids that were historically used in drilling activities. The toxic components of the oil based fluids have been essentially removed in the synthetic based fluid, rendering them virtually non-toxic (Section 2.9.2).

SBMs are used in potentially difficult drilling situations, such as wells drilled in reactive shales, those with higher bottom-hole temperatures associated with deeper rock, and horizontal and extended-reach wells where WBMs do not offer consistently good drilling performance. SBM does not react with high clay content shales where WBM hydrates the shales, causing them to become unstable and slough into the wellbore, potentially collapsing around the bottom hole assembly (BHA) or drill string. SBM is a more thermally stable fluid across a wide range of temperatures and will maintain its properties such as hydrostatic overbalance longer than WBMs. SBM supresses the formation of gas hydrates. SBM will have a significant advantage in the event of a well control situation. Gas bubbles will not migrate like in WBM as long as the gas remains in solution. WBM will have greater susceptibility to plugging of well control equipment.

Although a specific SBM drilling fluid has not yet been identified for the Project, the final selection of drill fluids will be conducted in accordance with the OCSG and their management will be carried out in accordance with the OWTG.

A high-level comparison between WBM and SBM is provided in Table 2.8. As noted, the preferred option is to use a combination of WBM and SBM, and the EIS considers and assesses the planned use of both fluid types as part of this Project.

Table 2.8 Identification and Evaluation of Drilling Fluid Options

Alternative	Potential Regulatory Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Considerations	Preferred Option and Rationale
WBM	YES Standard / routine and approved activity.	YES Use of WBM for initial hole sections when drilling	YES Use of WBM for initial hole sections when drilling	Standard / routine and approved activity. Use in accordance with regulatory	**YES** Use of WBM for initial hole sections when drilling without riser installed

Alternative	Potential Regulatory Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Considerations	Preferred Option and Rationale
	Use in accordance with regulatory requirements	without riser installed BUT Technically inferior in deeper sections of well (particularly associated with borehole instability)	without riser installed BUT With high probability of increased non-productive time (NPT) and cost associated with borehole stability problems for deeper well sections	requirements	
SBM	YES Standard / routine and approved activity. Use in accordance with regulatory requirements	YES Technically feasible and superior for deeper sections of well	YES Use of SBM for deeper hole sections when riser installed	Standard / routine and approved activity. Use in accordance with regulatory requirements	**YES** SBM likely to be used at deeper well sections, when riser installed. Fluids use and cuttings treatment and disposal in accordance with applicable regulatory requirements

2.10.2 MODU Selection

A number of types of MODUs can be used to drill a well once a specific well location or target is determined, with three types of installations typically being used to drill offshore wells in Atlantic Canada: 1) semi-submersibles; 2) drill ships; and 3) jack-up rigs. The overall (technical) feasibility of using each type of MODU and its eventual selection is often EL and well-specific, being based primarily on the characteristics of the physical environment at the proposed drill site including water depth, required drilling depth and expected weather and ice conditions and associated mobility requirements.

The overall characteristics of semi-submersible MODUs and drill ships were described earlier in Section 2.5.1. Jack-ups are typically used in relatively shallow water depths of between 10 and 100 m. After being towed to the drill site the unit's retractable legs are lowered until they come into contact with and rest upon the sea floor, and the drilling barge or unit platform is then elevated up the legs until it is at the desired height above the sea surface. Due to the water depths and environmental conditions present

in the ELs that comprise the Project Area, the use of a jack-up MODU is not considered to be a technically feasible option for this Project.

Based on the water depths and other environmental conditions involved and associated technical and operational requirements for this Project, drilling activities will therefore be carried out using a harsh environment floating semi-submersible or a drill ship MODU. Both of these options are being carried forward into the EIS, and one or both of these MODU types may be used for the Project.

Table 2.9 provides an evaluation of the various MODU options based on regulatory, technical, economic and environmental considerations.

Table 2.9 Identification and Evaluation of MODU Options

Alternative	Potential Regulatory Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Considerations	Preferred Option and Rationale
Semi-Submersible	YES	YES	YES	Both semi-submersible and drillship options can be used in environmentally acceptable manner, provided that appropriate approvals and mitigations are implemented	**YES** Both semi-submersibles and drillships may be used for the Project and are therefore assessed in the EIS
Drill Ship	YES	YES	YES		
Jack-Up	YES	NO	Not considered viable given Project requirements and environmental conditions		

Over the life of the Project, there may be multiple types of MODUs actively engaged in drilling activities in the Project Area at any one time. Nexen's overall process for MODU selection will evaluate the various options in light of their particular characteristics against specific well site conditions and Nexen requirements. As described in Sections 2.2 and 2.5.1, a competitive process will be used to select and procure the particular MODU(s) that will be used for this Project.

2.10.3 Drilling Waste Management

An overview of drilling fluids, cuttings and associated waste materials and their management was provided earlier in Section 2.9.2. All such materials and their utilization and disposal for this Project will be in accordance with applicable regulatory requirements, including the OWTG and other applicable guidelines and standards. Generally there are three potential options for the management of drilling waste: 1) Disposal at sea, 2) Shipping waste to shore, and 3) Re-injection.

As the first two to three hole sections of a well are drilled without a riser in place, the WBMs and associated cuttings that are used in and result from these initial drilling activities are discharged directly to the seabed. WBMs may be discharged onsite from offshore installations where these meet applicable guidelines and other regulatory requirements.

When the riser and blow-out preventer are installed and in place, drill fluids and cuttings can be returned to the surface and on to the MODU for recovery and reuse. Once onboard the MODU, drill cuttings are removed from the drilling fluids in successive separation stages. Some fluids are reconditioned and reused, while spent SBM is returned to shore for disposal. Under the OWTG, SBM-associated drill cuttings may be discharged into the marine environment, provided they are appropriately treated prior to discharge in accordance with proven and practicable best available technologies and practices (defined as a concentration of 6.9 g / 100 g or less oil on wet solids). Other than any residual base fluid retained on cuttings, no whole SBM is currently permitted to be discharged to the sea.

Potential alternatives for the disposal of these SBM-associated drill cuttings include overboard discharge after treatment as described above, re-injection into an approved disposal well (i.e., a dedicated well which must be designed for injection) or shipment to shore for disposal at an approved waste management facility. In terms of the latter, there are currently no existing, approved treatment facilities in Newfoundland and Labrador to treat and dispose of SBM-associated cuttings. The cuttings would thus have to be shipped to shore in Newfoundland and then trucked to the nearest waste treatment facility elsewhere in Eastern Canada. In addition to creating technical requirements and logistical challenges, and being far more costly, this option would also have environmental implications due to the air emissions associated with this additional transportation activity (by vessel and then by truck), as well as with the eventual onshore treatment and disposal of this waste. In addition, this activity has the potential to introduce an important HSE risk associated with handling a fleet of cuttings boxes and also given the number of cargo lifts that this would require both off the MODU and onto the dock. As well, there would be additional environmental exposure onshore between the supply base and onshore disposal facility.

A potential re-injection option would involve on board processing of the cuttings waste into a slurry and then pumping it into an approved, dedicated disposal well. Although re-injection from fixed wellhead platforms is a proven technology and is being used or planned for use for large-scale (production) offshore projects off Newfoundland such as Hibernia or Hebron, there is little or no experience with its use offshore Newfoundland and Labrador during exploration drilling. Re-injection of cuttings in a dedicated disposal well is therefore not considered to be a technically or economically feasible alternative for this exploration drilling program.

A summary of the evaluation of these various drilling waste disposal options is provided in Table 2.10. As noted, the preferred alternative and planned approach for the Project is the disposal of WBM and associated drill cuttings at sea and treatment of SBM-associated cuttings on the MODU prior to discharge at sea, both of which are standard and approved practices that are undertaken routinely for similar exploration activities in this jurisdiction.

Table 2.10 Identification and Evaluation of Drilling Waste Disposal Options

Alternative	Potential Regulatory Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Considerations	Preferred Option and Rationale
Discharge to Water Colum (Following treatment, as applicable)	YES	YES	YES	Non-toxic, but with some localized seabed effects	**YES**
Ship to Shore	YES	YES	YES Potentially, but costs from increased transportation and operational delays	Air emissions and environmental exposure (vessels and trucking)	**NO**
Offshore Reinjection	YES	NO	Not considered a feasible alternative (See above)		**NO**

2.10.4 Water Management and Location of Final Effluent Discharge Points

The various liquid wastes and associated effluent discharges that will or may be associated with planned Project activities were described earlier in Section 2.9. As a specific MODU has yet to be selected for the Project, and because the particular equipment and “discharge points” that are associated with these emissions on a MODU are fixed and cannot be changed or re-configured, Nexen is unable to evaluate and select alterative discharge points as part of its Project planning and design process.

Any MODU proposed to be operated off Newfoundland and Labrador must be evaluated and granted an Operations Authorization by the C-NLOPB, along with a Certificate of Fitness issued by a recognized certifying authority, in accordance with requirements of the Accord Acts. All effluent discharge systems and other components onboard any MODUs and vessels eventually selected and used for this Project will comply with relevant legislation and regulations.

2.10.5 Offshore Lighting

On-board lighting will be required for all Project activities that occur at night, and must be in place and activated on the MODUs and any supply vessel and aircraft for safety and regulatory compliance reasons. Lighting will be kept to a minimum to the extent that it does not affect crew and vessel safety, nor the safety of other marine vessels and activities.

Spectral modified lighting, which uses coloured (blue or green) light has been tested on offshore production installations and has shown environmental benefits in terms of reduced attraction of marine associated birds (Marquenie et al 2013). This technology has not, however, been proven to be technically or economically feasible at a commercial scale, and there are potential safety concerns with some types of spectral lighting and their use in the offshore and elsewhere (Poot et al 2008). Although this form of lighting has been shown to satisfy regulatory requirements in some jurisdictions, its use in

the Newfoundland and Labrador offshore is currently restricted by its commercial availability, limited capability in extreme weather, and safety concerns related to helicopter approach / landing in certain instances (Marquenie et al 2014) (Table 2.11).

For this Project, the use of artificial lighting will be minimized to the greatest extent possible (without compromising safe operations), particularly when migratory birds are especially vulnerable to disturbance (e.g., during spring and fall migration, inclement weather, see Chapter 9). This may include minimizing the amount, duration and frequency of pilot warning and obstruction avoidance lighting; shielding lights downward so that the light is directed toward the deck; and using strobe lights instead of solid-burning or slow pulsing warning lights at night where possible. In all cases, however, safety will be the primary consideration in determining the nature and amount of lighting used. Lighting is task specific by design, and where safe and technically feasible some amount of reduced lighting may be considered.

Due to operational and regulatory requirements related to offshore lighting, light types and levels will be selected and implemented so as to ensure that the safety of the Project personnel and equipment and other ocean uses, as well as the operational requirements of the Project, are not compromised.

Table 2.11 Identification and Evaluation of Lighting Options

Alternative	Potential Regulatory Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Considerations	Preferred Option and Rationale
No Lighting or Limited Lighting	NO	Not considered a feasible alternative			
Standard Lighting	YES	YES	YES	Potential localized effects on marine avifauna	**YES**
Spectral modified lighting	YES	NO	NO Restricted by commercial availability and cost	Potential for reduced interactions with marine avifauna	**NO**

2.10.6 Well Testing – Nighttime Flaring

Formation flow testing may be carried out as part of this Project on wells where hydrocarbons are discovered, and is required by the C-NLOPB as part of the process for declaration of a significant discovery. Produced hydrocarbons and a small amount of produced water may then be flared using high-efficiency burners, while larger amounts of produced water in excess of flare capacity may be treated in accordance with the relevant regulatory requirements prior to ocean discharge.

Flaring is a required activity during a formation flow test to safely and efficiently dispose of hydrocarbons that may come to surface, and thus the option of no flaring is not considered to be a feasible option. Flaring may be required during the series of flow periods which could last one to three days per period. One potential approach may be to adjust the timing of flaring to attempt to avoid doing so at night, and thus, the potential to attract and affect nocturnal seabirds. Since well testing can last up to several days in duration, once well testing begins, it is impossible to avoid night time flaring and it is necessary to

complete the test in order to not negatively affect the test results. Doing so would also prolong the overall duration of the well test which would increase its costs, as well as its overall environmental footprint due to additional emissions. There are also added safety concerns as the live well would be open for a longer period of time (Table 2.12).

Table 2.12 Identification and Evaluation of Flaring at Night Options

Alternative	Potential Regulatory Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Considerations	Preferred Option and Rationale
No Flaring	NO Well testing is required to obtain an SDL	NO	NO	Not considered a feasible alternative	
Reduced Flaring (no flaring at night or during low-visibility weather)	YES	NO Testing can last several days so night time flaring cannot be avoided	YES If flaring is shut down at the night, well test will need to be extended meaning higher cost, and higher overall risk exposure	Potential for reduced interactions with marine avifauna, but with increased emissions and overall duration of flaring Increased risks of spills associated with starting and stopping flaring activities	**NO**
Flaring as Required	YES	YES	YES	Potential localized effects on marine-associated birds	**YES**

2.10.7 Chemical Selection

As the specific drill fluids and other materials (including chemicals) that are to be used for the Project, have yet to be identified and selected, Nexen is unable to evaluate and select alternative chemicals as part of its Project planning and design processes.

As part of Project planning and eventual operations, Nexen and its contractors will undertake the selection and screening of chemicals pursuant to the detailed guidance and effective procedures outlined in the OCSG. Nexen will develop a Chemical Screening and Management Plan that will meet or exceed all regulatory requirements.

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3 GOVERNMENTAL, INDIGENOUS AND STAKEHOLDER ENGAGEMENT

Engagement is considered to be the cornerstone of the EA process, and is a key component of Nexen's approach to the planning and implementation of its oil and gas exploration programs and other business activities. A number of associated initiatives have been undertaken, are in progress, or are being planned in relation to the Project, including discussions with relevant government departments and agencies, Indigenous groups and stakeholder organizations.

Nexen's engagement activities for this Project and its EA have been designed and implemented using various mechanisms to share and receive information and perspectives about the Project. This approach has provided interested and potentially affected groups and individuals with information on the Project, and has allowed them to formulate informed questions and concerns and to provide feedback.

A key objective of Nexen's EA engagement program to date has been to provide detailed Project information, and to gather comments, questions, concerns and issues related to the Project and its potential environmental effects that require consideration in the EIS. This feedback also provides valuable input to support on-going and future Project planning.

3.1 EIS Guidelines

The EIS Guidelines issued to Nexen by the Agency specify various information requirements and potential issues that are required to be addressed in the EIS, including required information and analysis around the Project description, aspects of the existing biophysical and socioeconomic environments, Indigenous and public engagement, potential environmental issues and interactions, mitigation and other items. The Guidelines have therefore formed a key part of the issues scoping component of EIS planning and preparation by Nexen.

The EIS Guidelines also outline a number of general principles (Part 1, Sections 2.2 and 2.3) and specific requirements around public participation and engagement with Indigenous groups as part of the EA process for the Project. This includes the following:

> *The EIS will describe the ongoing and proposed public participation activities that the proponent will undertake or that it has already conducted on the project. It will provide a description of efforts made to distribute project information and provide a description of information and materials that were distributed during the consultation process. The EIS will indicate the methods used, where the consultation was held, the persons and organizations consulted, the concerns voiced and the extent to which this information was incorporated in the design of the project as well as in the EIS. The EIS will provide a summary of key issues raised related to the project and its potential effects to the environment as well as describe any outstanding issues and ways to address them.* (Part 2, Section 4).
>
> *With respect to engagement activities, the EIS will document:*
> - *the engagement activities undertaken with each group prior to the submission of the EIS, including the date and means of engagement (e.g. meeting, mail, telephone);*
> - *any future planned engagement activities; and*

- *how engagement activities by the proponent allowed groups to understand the project and evaluate its effects on their communities, activities, potential or established section 35 rights, including title and related interests.*

In preparing the EIS, the proponent will ensure that groups have access to timely and relevant information on the project and how the project may adversely impact them. The proponent will structure its engagement activities to provide adequate time for groups to review and comment on the relevant information. Engagement activities are to be appropriate to the groups' needs, arranged through discussions with the groups and in keeping with established consultation protocols, where available. The EIS will describe all efforts, successful or not, taken to solicit the information required from groups to support the preparation of the EIS.

The proponent will ensure that views of groups are recorded and that groups are provided with opportunities to validate the interpretation of their views. The proponent will keep detailed tracking records of its engagement activities, recording all interactions with groups, the issues raised by each group and how the proponent addressed the concerns raised. The proponent will share these records with the Agency.

For the groups listed…[in these Guidelines].. the proponent will ensure they are notified about key steps in the EIS development process and of opportunities to provide comments on key EA documents and/or information to be provided regarding their community. The proponent will ensure these groups are reflected in the baseline information and assessment of potential environmental effects as described under paragraph 5(1)(c) of CEAA 2012 and/or impacts to potential or established section 35 rights, including title and related interest in the EIS. (Section 5.1)

These and other procedures and requirements for engagement are also reflected and referenced throughout the EIS Guidelines, including specifications about the conduct of these activities, and the manner in which their outcomes are to be used in the planning and completion of the EIS.

This EIS has been developed and submitted in accordance and full compliance with the above referenced EIS Guidelines. A Table of Concordance that identifies where each item has been addressed in the EIS is included at the beginning of this EIS.

3.2 Government Departments and Agencies

Nexen recognizes that a number of federal and provincial government departments and agencies have specific responsibilities or interests related to the Project and its potential environmental effects.

Nexen engaged with various government departments and agencies during the development of the Project Description at the EA review initiation stage. The subsequent governmental review of that Project Description also identified important environmental issues related to the Project, and this input was considered by the Agency in determining whether a federal EA was required and the scope and focus of that review, as reflected in the EIS Guidelines.

In planning and developing the EIS, Nexen has continued to engage with these and other regulatory agencies to share information on the Project, identify and obtain useful and relevant environmental

baseline information for the EIS, and identify any other issues which required consideration in the assessment. A summary of Project-related meetings and discussions involving federal and provincial government departments and agencies is provided in Table 3.1 (to January 19, 2018), along with a listing of the various issues raised and an indication of where each of these is addressed in the EIS. As indicated in the table, Nexen's engagement initiatives with government departments and agencies have also included discussions and information sharing through various other means (e.g., through letters, email, telephone conversations), the results of which have also been considered in the scope and content of the EIS as applicable.

Table 3.1 Meetings and Discussions with Government Departments and Agencies

Date	Organization	Type/Format	Topic
May 1, 2016	NL Department of Natural Resources	Meeting	Introduction to Nexen and senior management; overview of planned activities
May 1, 2016	C-NLOPB	Meeting	Introduction to Nexen and senior management; overview of planned activities
May 2, 2016	NL Department of Environment and Conservation	Meeting	Introduction to Nexen and senior management; overview of planned activities
May 3, 2016	Nalcor Energy	Meeting	Introduction to Nexen and senior management; overview of planned activities
November 15, 2016	Nalcor Energy	Meeting	Update on Nexen's planned activities; Nalcor activity update
November 16, 2016	C-NLOPB	Meeting	Discussion of Project and associated regulatory activity
November 16, 2016	NL Department of Natural Resources	Meeting	Discussion of Nexen and its past and proposed oil and gas activities
November 18, 2016	Canadian Environmental Assessment Agency	Meeting	Discussion of Nexen, the Project and federal EA process
December 5, 2017	Canadian Environmental Assessment Agency	Meeting	Update on EIS preparation and associated engagement processes
December 6, 2017	Major Projects Management Office	Meeting	Update on Nexen activities, plans and EIS preparation
December 6, 2017	Natural Resources Canada	Meeting	Update on Nexen activities, plans and EIS preparation
January 18, 2017	Canadian Environmental Assessment Agency	Telephone Discussion	Update on planned EA initiation, including Project Description content and its review, and EA related engagement processes
January 26, 2017	C-NLOPB	Telephone Discussion	Update on Project and planned EA initiation (Project Description)
January 27, 2017	Major Projects Management Office (MPMO), Natural Resources Canada	Meeting	Introduction to Project and discussion of associated federal regulatory processes
February 2, 2017	Canadian Environmental Assessment Agency	Telephone Discussion	Project Description submission (content and review)

Date	Organization	Type/Format	Topic
February 9, 2017	Canadian Environmental Assessment Agency	Telephone Discussion	Project Description submission (content and review)
March 9, 2017	Environment and Climate Change Canada	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Department of National Defence (Maritimes)	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Fisheries and Oceans Canada	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Health Canada	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Natural Resources Canada	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Transport Canada	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	NL Department of Fisheries, Forestry and Agrifoods	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	NL Department of Municipal Affairs and Environment	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	NL Department of Natural Resources	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	St. John's Port Authority	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 22, 2017	C-NLOPB	Meeting	Discussion of Project and associated regulatory processes
March 22, 2017	NL Department of Natural Resources	Meeting	Discussion of Project and associated regulatory processes
March 29, 2017	NL Department of Natural Resources	Meeting	Discussion of Project and associated benefits planning
June 1, 2017	C-NLOPB, NL Department of Natural Resources	Meeting	Discussion of Project and associated regulatory and stakeholder engagement processes
June 2, 2017	NL Department of Municipal Affairs and Environment	Meeting	Discussion of Project and associated regulatory and stakeholder engagement processes
October 16, 2017	Canadian Environmental Assessment Agency	Telephone Discussion	Update on EA process and EIS preparation
October 25, 2017	C-NLOPB	Meeting	Update on Nexen activities and plans offshore NL
November 21, 2017	C-NLOPB	Meeting	Update on Nexen activities and plans offshore NL
November 28, 2017	Canadian Environmental Assessment Agency	Meeting	Update on EA process and EIS preparation. Discussion of Indigenous groups, interests, and engagement processes, environmental baseline information, EIS structure and methods, eventual review process.

Date	Organization	Type/Format	Topic
November 30, 2017	Fisheries and Oceans Canada	Meeting	Project overview, EA process, planned EIS format and content, environmental baseline data, possible effects on Atlantic salmon, marine mammals (and mitigations, including MMOs) and corals, potential follow-up requirements.

Key Questions and Issues Raised	Where Addressed in the EIS
Planned Project components and activities, including schedule	Section 2.5, 2.6, 2.7
EA and other regulatory processes and requirements	Section 1.3
EA initiation, planned EIS structure and content	Section 1.0, 1.4
Environmental baseline data (especially, benthos)	Section 5.0, 6.0, 7.0
Indigenous groups and their interests, engagement processes	Section 7.4
Project socioeconomic benefits	Section 2.2
Stakeholder consultation	Section 3.4
Interests in, and potential effects on, Atlantic salmon	Section 3.3, 6.1.8, 8.4.4, 12.3
Corals and sponges and associated mitigations	Section 6.1.6, 8.3.2
Environmental monitoring and follow-up	Section 4.3.4, 8.6, 9.6, 10.6, 11.5, 12.5, 13.5, 14.5, 18.4

3.3 Indigenous Groups

Nexen is committed to ensuring that Indigenous groups are appropriately informed and engaged regarding the company's on-going and planned activities. Nexen's engagement initiatives are designed to allow for meaningful engagement with Indigenous communities and organizations using multiple forms of engagement including letters, meetings, phone conversations, email dialogue, and other means, as per the preferences of each particular group. The objective is to establish and maintain constructive relationships with Indigenous groups potentially affected by the Project through on-going communications, and the sharing of information in an open, cooperative and respectful manner.

The following principles guide Nexen's engagement with Indigenous peoples:

- Integrity, transparency and respect inform engagement to build trust and long-term relationships with Indigenous groups.
- Early engagement based on open and honest dialogue to provide Indigenous groups time to develop an understanding of business activities and review information materials.
- Intentional listening to determine how Indigenous groups' leadership and members want Nexen to communicate with them, and tailoring engagement practices to reflect what we heard.
- Collaboration with Indigenous groups to determine potential Project impacts and develop mitigation strategies.

- Culturally appropriate engagement practices to foster inclusion, shared understanding, collaborative problem solving, and respect for the unique interests, customs and cultures of Indigenous groups.

- Respect for human rights and the rights and distinct cultures and traditions of Indigenous groups to facilitate meaningful dialogue;

- Recognition that Indigenous peoples do or may have constitutionally protected Aboriginal and Treaty Rights under Section 35 of the *Constitution Act 1982*; and

- Responsiveness facilitated through the provision of accessible mechanisms for Indigenous groups to provide feedback, express concerns or submit complaints, and implement processes to document, investigate and provide timely follow-up, to ensure appropriate action is taken.

3.3.1 Overview of Nexen's Indigenous Engagement for the EIS

In March 2017 Nexen wrote to each of the following Newfoundland and Labrador Indigenous groups::

1) Labrador Inuit (Nunatsiavut Government)
2) Labrador Innu (Innu Nation),
3) NunatuKavut Community Council,
4) Miawpukek First Nation, and
5) Qalipu Mi'kmaq First Nation Band.

The correspondence provided an initial notification of and overview of the Project, and an opportunity for these groups to identify any questions or comments regarding the Project and its potential environmental effects for consideration in the EIS, as well as inviting further information sharing and engagement as the EA progresses. In addition, Nexen has individually followed up with each group to confirm receipt of correspondence, and to identify a specific contact for future engagement.

In July 2017, similar correspondence and Project overview information was also sent to each of the following Indigenous groups in the Maritime Provinces and Quebec, which had subsequently been identified by the Agency as requiring engagement as part of the ongoing CEAA 2012 assessments for several other similar offshore exploration drilling projects of Eastern Newfoundland. These groups (as listed below) were included in the EIS Guidelines issued for the Project (Section 5.1).

Nova Scotia

- 11 Mi'kmaq First Nation groups represented by Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO):
  - Acadia First Nation
  - Annapolis Valley First Nation
  - Bear River First Nation
  - Eskasoni First Nation
  - Glooscap First Nation
  - Membertou First Nation
  - Paqtnkek Mi'kmaw Nation
  - Pictou Landing First Nation

- Potlotek First Nation
- Wagmatcook First Nation
- Waycobah First Nation

- Millbrook First Nation
- Sipekne'katik First Nation

New Brunswick

- Eight Mi'gmaq First Nations groups represented by Mi'gmawe'l Tplu'taqnn Inc. (MTI)
  - Fort Folly First Nation
  - Eel Ground First Nation
  - Pabineau First Nation
  - Esgenoôpetitj First Nation
  - Buctouche First Nation
  - Indian Island First Nation
  - Eel River Bar First Nation
  - Metepnagiag Mi'kmaq First Nation
- Elsipogtog First Nation
- Five Maliseet First Nation groups represented by Wolastoqey Nation of New Brunswick (WNNB):
  - Kingsclear First Nation
  - Madawaska Maliseet First Nation
  - Oromocto First Nation
  - Saint Mary's First Nation
  - Tobique First Nation
- Woodstock First Nation
- Peskotomuhkati Nation at Skutik (Passamaquoddy)

Prince Edward Island

- Abegweit First Nation
- Lennox Island First Nation

Quebec

- Three Mi'gmaq First Nation groups represented by Mi'gmawei Mawiomi Secretariat (MMS)
  - Micmas of Gesgapegiag
  - La Nation Micmac de Gespeg
  - Listuguj Mi'gmaq Government
- Les Innus de Ekuanitshit
- Montagnais de Nutashkuan

These initial letters were followed by a number of subsequent engagement initiatives throughout the preparation of the EIS, an overview of the nature, intent and results of which were described in detail below. This included a second letter in November 2017 to follow-up on the introductory correspondence, and to request information related to any relevant traditional land and resource use activities and traditional knowledge. Follow-up emails and phone calls were made to all 41 Indigenous groups in Eastern Canada to confirm receipt of previous correspondence and their level of interest in the Project, as well as to identify any preliminary concerns and interest in meeting with Nexen.

The engagement activities to date have allowed interested groups to understand the Project and evaluate its potential effects on their communities, activities, and potential or established section 35 rights, including title and related interests. In conducting its engagement activities for the Project, Nexen has attempted to follow all applicable engagement protocols and has provided each group with adequate time to review and comment on the information provided.

As illustrated, Nexen has been making considerable efforts to engage with each of the Indigenous groups to provide and receive information on the Project and its potential environmental effects. The key elements of Nexen's Indigenous engagement for the Project include:

- Providing Indigenous groups with information on the Project, including its purpose, location, associated components and activities and schedule;

- Identifying and documenting any questions or concerns about the Project and potential environmental effects, including whether and how these effects might have implications for Indigenous communities and their activities and interests, including possible impacts on potential or established Aboriginal or Treaty Rights, or on the various factors outlined in Section 5(1)(c) of CEAA 2012.

- Seeking to collect and share information on any Indigenous activities or interests in or near the Project Area or elsewhere that might be relevant to the assessment of the Project and its potential effects, as well as relevant Indigenous knowledge about the area and its environment; and

- Discussing possible approaches and mitigation measures to avoid or reduce any likely effects of the Project on Indigenous groups, their interests and activities and on the environment in general.

The remainder of this chapter provides an overview of Nexen's engagement activities to date with Indigenous groups (to January 19, 2018), including the nature and outcomes of these initiatives.

Where Indigenous groups have chosen to participate in such engagement initiatives, the information and insights obtained through these processes were considered and incorporated throughout the EIS. A number of groups have, however, not responded or otherwise provided information on their activities and interests or communicated any associated questions or concerns regarding the Project and its potential effects. In these cases, the EIS has utilized existing and publicly available information. Nexen respects the views and wishes of the communities in this regard, and has continued to be open to discussion and cooperation with these groups. Nexen also encourages these communities and organizations to provide any relevant input and information that they may have directly to the Agency as part of the EIS review process.

3.3.2 Indigenous Traditional Knowledge

As described in Section 12.1, the EIS Guidelines include extensive reference to the "current use of lands and resources for traditional purposes" by Indigenous peoples, and to "potential adverse impacts on potential or established Aboriginal or Treaty Rights protected under section 35 of the *Constitution*

Act, 1982" (see Sections 2.3, and elsewhere). They likewise reference the collection and integration of traditional knowledge from Indigenous groups into the EIS, some examples of which include:

> *The proponent will make reasonable efforts to integrate Aboriginal traditional knowledge into the assessment of environmental effects (Section 2.3)*
>
> *Aboriginal traditional knowledge refers to knowledge acquired and accumulated by a local community or an Indigenous group… The proponent will incorporate into the EIS the community knowledge and Aboriginal traditional knowledge to which it has access or that is acquired through public participation and engagement with Indigenous groups, in keeping with appropriate ethical standards and obligations of confidentiality. The proponent will integrate Aboriginal traditional knowledge into all aspects of its assessment including both methodology (e.g. establishing spatial and temporal boundaries, defining significance criteria) and analysis (e.g. baseline characterization, effects prediction, development of mitigation measures)….Agreement should be obtained from Indigenous groups regarding the use, management and protection of their* existing traditional knowledge information during and after the EA. (Section 4.2.2)

The Agency's Reference Guide "*Considering Aboriginal Traditional Knowledge in Environmental Assessments conducted under CEAA 2012*" (updated March 2015) provides additional information and guidance on the definition and use of aboriginal traditional knowledge (ATK), including:

> *ATK can be viewed as knowledge that is held by, and unique to, Aboriginal peoples … Generally, ATK is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. ATK is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.*
>
> *While those involved in EA will likely be most interested in traditional knowledge about the environment (or, traditional ecological knowledge), it must be understood to form a part of a larger body of knowledge which encompasses knowledge about cultural, environmental, economic, political and spiritual inter-relationships.*

As discussed and illustrated in Section 2.5, the proposed activities that comprise this Project will be located at a considerable distance from any Indigenous groups and their communities (ie, over 400 km from land and at least 635 km from any Indigenous community), and from the known traditional territories and activities associated with each of these groups. Nexen is not aware that any Indigenous groups hold, claim or assert Aboriginal or Treaty rights or otherwise undertake traditional activities within or near the proposed Project Area, pursuant to section 35 of the *Constitution Act, 1982*. Although fishing enterprises associated with several of these organizations undertake commercial fishing activity within NAFO Divisions that overlap parts of the Project Area (Sections 7.2 and 12.3), it is understood that these organizations undertake fishing activities off Eastern Newfoundland through commercial licences issued by the federal government. As "traditional use" is again generally understood to mean activities that have been exercised by an identifiable Indigenous community since the time of European contact or control of a specific area, these contemporary, commercial land and resource use activities may not be considered traditional in that they are not a continuation of ancestral activities that took place

historically within this area offshore Eastern Newfoundland. Specifically, given the location of the Project Area, it is unlikely that traditional activities ever took place in or near the area.

In planning and completing this EIS, and in undertaking its associated Indigenous engagement program, Nexen has been mindful of the potential relevance and use of traditional knowledge, and the associated requirements of CEAA 2012 and the EIS Guidelines in that regard. It has therefore made reasonable efforts to integrate traditional knowledge related to the Project and its existing environment and potential effects, where such knowledge is known to exist and/or is identified and communicated by the holders of that knowledge. Nexen's correspondence with each of the identified Indigenous groups, for example, made specific reference to traditional knowledge and invited each group to indicate whether they possessed such knowledge related to the Project and its potential effects, for discussion and possible use in the EIS.

In no cases, however, did any of the Indigenous groups identify the existence of relevant traditional knowledge for use in the EIS as part of Nexen's engagement program. While it is not known whether this was due to an overall lack of traditional use and historical occupancy in and near the Project Area, or other reasons, Nexen respects the views and wishes of the Indigenous groups in that regard, and has endeavoured to incorporate all other inputs and information provided by Indigenous groups into the EIS.

Nexen also remains open to receiving and considering any such traditional knowledge or other inputs and perspectives from Indigenous groups as part of its planned engagement initiatives throughout the course of the Project (Section 12.5).

3.3.3 Newfoundland and Labrador Indigenous Groups

3.3.3.1 Labrador Inuit (Nunatsiavut Government)

A summary of engagement initiatives with the Nunatsiavut Government to date is provided in Table 3.2, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.2 Engagement Activities with Nunatsiavut Government and Key Outcomes

Date	Engagement Activity	Purpose
March 9, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge
November 30, 2017	Nexen Email	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen.
December 1, 2017	Nexen Email	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen.
December 8, 2017	Telephone Discussion	Confirmed receipt of correspondence, discussion of Project, commercial fishing licences, future engagement processes,

Date	Engagement Activity	Purpose
		and Atlantic salmon migrations, interest in meeting with Nexen.
December 18, 2017	Nexen Letter	Provided copy of Atlantic Salmon Report and offered to meet in early 2018.

Key Questions and Issues Raised	Where Addressed in the EIS
EA review processes and associated engagement procedures	Section 1.3.1, 3.0
Indigenous commercial fishing licences in the area	Section 7.2.5, 7.4, 12.3
Atlantic salmon migrations and potential effects	Section 3.3, 6.1.8, 8.4.4, 12.3

3.3.3.2 Labrador Innu (Innu Nation)

A summary of engagement initiatives with Innu Nation to date is provided in Table 3.3, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.3 Engagement Activities with Innu Nation and Key Outcomes

Date	Engagement Activity	Purpose
March 9, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge
November 30, 2017	Nexen Telephone Call	Made appointment to speak by telephone on Dec 4 2017 to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen.
December 4, 2017	Nexen Email and Telephone Call	Rescheduled telephone meeting to Dec 5 2017
December 5, 2017	Telephone Discussion	Discussion of Project, fishing licences, future engagement processes, and Atlantic salmon report
December 18, 2017	Nexen Letter	Provided copy of Atlantic Salmon Report and offered to meet in early 2018.

Key Questions and Issues Raised	Where Addressed in the EIS
EA review processes and associated engagement procedures	Section 1.3.1, 3.0
Indigenous commercial fishing licences in the area	Section 7.2.5, 7.4, 12.3
Atlantic salmon migrations and potential effects	Section 3.3, 6.1.8, 8.4.4, 12.3

3.3.3.3 NunatuKavut Community Council

A summary of engagement initiatives with the NunatuKavut Community Council to date is provided in Table 3.4, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.4 Engagement Activities with NunatuKavut Community Council and Key Outcomes

Date	Engagement Activity	Purpose
March 9, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)

Date	Engagement Activity	Purpose
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge
November 30, 2017	Nexen Email	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen
December 4, 2017	Telephone Discussion	Discussion of Project, commercial fishing licences, future engagement processes, Atlantic salmon report, potential business opportunities associated with the Project
January 16, 2018	Nexen Email	Provided copy of Atlantic Salmon Report and offered to meet in early 2018.

Key Questions and Issues Raised	Where Addressed in the EIS
EA review processes and associated engagement procedures	Section 1.3.1, 3.0
Indigenous commercial fishing licences in the area	Section 7.2.5, 7.4, 12.3
Atlantic salmon migrations and potential effects	Section 3.3, 6.1.8, 8.4.4, 12.3

3.3.3.4 Miawpukek First Nation

A summary of engagement initiatives with the Miawpukek First Nation to date is provided in Table 3.5, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.5 Engagement Activities with Miawpukek First Nation and Key Outcomes

Date	Engagement Activity	Purpose
March 9, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document) (Also sent to Mi'kmaq Alsumk Mowimsikik Koqoey Association)
July 27, 2017	Miawpukek First Nation Letter (Received)	Outlined concerns with Project and its potential effects on lands (including fishing grounds) and resources used by its members for traditional and commercial purposes. Request for participation funding.
August 28, 2017	Nexen Email (Letter)	Nexen response acknowledging receipt of July 27, 2017 letter, and requesting meeting to follow-up on issues raised
November 8, 2017	Nexen Email	Confirm receipt of original information and requesting information regarding potential impacts to rights.
November 10, 2017	Nexen Email	Nexen follow-up to August 2017 correspondence, attempt to set up meeting
November 30, 2017	Nexen Telephone Call	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen
December 1, 2017	Nexen Email	Nexen representative followed up to confirm receipt of previous correspondence and discuss Project and any issues (resent email and left voicemail)
December 4, 2017	Telephone Discussion	Discussion of Project and future engagement processes, including discussions of Atlantic salmon migrations, possible oil spill effects, swordfish and associated fisheries

Date	Engagement Activity	Purpose
December 12, 2017	Nexen Letter	Provided copy of Atlantic Salmon Report and offered to meet in early 2018.

Key Questions and Issues Raised	Where Addressed in the EIS
EA review processes and associated engagement procedures and capacity / funding issues	Section 1.3, 3.3
Indigenous commercial fishing licences in the area, including fishing resources in the Project Area that support traditional activities, jobs, well-being and culture	Section 7.2.5, 7.4, 12.3
Atlantic salmon migrations (outgoing smolts and spawning adults) and potential effects	Section 3.3, 6.1.8, 8.4.4, 12.3
Potential oil spills and their effects, including on any “in river” fisheries	Section 16.6.2, 16.6.6, 16.6.7
Need for additional salmon data and research	Section 3.3, 6.1.8, 8.4.4, 12.3
Commercial swordfish fisheries and possible effects on these	Section 7.2.5, 7.4, 12.3.3
Possible effects of operations and spills, leaks, releases of oil on fishing resources in the Project Area	Section 16.6.2, 16.6.6, 16.6.7
Cumulative effects of drilling with other activities and their effects (fishing, forestry, aquaculture)	Section 15.0
Training and capacity building	Section 2.2

3.3.3.5 Qalipu Mi’kmaq First Nation Band

A summary of engagement initiatives with the Qalipu Mi’kmaq First Nation Band to date is provided in Table 3.6, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.6 Engagement Activities with Qalipu Mi’kmaq First Nation Band and Key Outcomes

Date	Engagement Activity	Purpose
March 9, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document) (Also sent to Mi'kmaq Alsumk Mowimsikik Koqoey Association)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge. (Also sent to Mi'kmaq Alsumk Mowimsikik Koqoey Association)
November 30, 2017	Nexen Email	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen.
December 5, 2017	Qalipu Letter (Received)	Overview of the Band and its membership, commercial fishing licences and potential effects on these, engagement processes, Project-related supply and transportation activities and the potential, for spills, drilling wastes, and the potential effects of a large oil spill.
December 18, 2017	Nexen Letter	Acknowledgement of December 5, 2017 letter

Key Questions and Issues Raised	Where Addressed in the EIS
Commercial fishing licences and activities	Section 7.2.5, 7.4, 12.3
EA related engagement processes	Section 1.3, 3.3

Key Questions and Issues Raised	Where Addressed in the EIS
Project-related supply and transportation activities and the potential, for spills	Section 2.5.2, 16.2.5, 16.6
Drilling wastes and their environmental effects	Section 2.9.2, 8.3.4, 9.3.4, 10.3.4, 11.3, 12.3, 13.3.4
The potential environmental effects of a large oil spill.	Section 16.6

3.3.4 Nova Scotia Indigenous Groups

A summary of engagement initiatives with the various Nova Scotia Indigenous groups identified earlier is provided in Table 3.7, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.7 Engagement Activities with Nova Scotia Indigenous Groups and Key Outcomes

Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO)

Aggregate body representing the Assembly of Nova Scotia Mi'kmaq Chiefs (ANSMC) that consists of Acadia First Nation, Annapolis Valley First Nation, Bear River First Nation, Potlotek First Nation, Eskasoni First Nation, Glooscap First Nation, Membertou First Nation, Paqtnkek First Nation, Pictou Landing First Nation, Wagmatcook First Nation, and We'koqma'q First Nation, with regard to engagement. For all engagement with KMKNO, Nexen understands that KMKNO is acting on behalf of the groups listed above.

Date	Engagement Activity	Purpose
November 24, 2017	Telephone discussion	Follow-up to initial correspondence that was sent to the ANSMC's 11 Mi'kmaq Chiefs and Councils, re-iterating availability to discuss Project and any concerns.

Key Questions and Issues Raised	Where Addressed in the EIS
KMKNO preference to engage through federal government processes, once EIS is available for review	n/a

Acadia First Nation, Annapolis Valley First Nation, Bear River First Nation, Potlotek First Nation, Eskasoni First Nation, Glooscap First Nation, Membertou First Nation, Paqtnkek First Nation, Pictou Landing First Nation, Wagmatcook First Nation, and We'koqma'q First Nation

Date	Engagement Activity	Purpose
July 14, 2017	Nexen Email (Letters)	Introduction to Project (including Project Overview document)
November 10, 2017	Nexen Email (Letters)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge

Key Questions and Issues Raised	Where Addressed in the EIS
None identified to Proponent	n/a

Millbrook First Nation

Date	Engagement Activity	Purpose
July 14, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 10, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge

Millbrook First Nation		
November 10, 2017	Millbrook Email (Received)	Confirmation by Millbrook of receipt of November 9, 2017 letter, requesting further information on timing of Project, funding availability and request for meeting.
November 16, 2017	Nexen Email	Response by Nexen to November 10, 2017 email.
December 1, 2017	Nexen Telephone Call	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen
December 4, 2017	Telephone Discussion	Arranged telephone discussion at a later date (see below).
December 4, 2017	Millbrook Letter (Received)	Expressed interest in meeting for face-to-face discussion regarding scope of Project, potential environmental effects and any potential impacts on Aboriginal or Treaty Rights of Mi'kmaq. Request for funding to support Millbrook's consultation and research
December 8, 2017	Telephone Discussion	Confirmed receipt of correspondence and interest in Project.
December 12, 2017	Nexen Letter	Provided copy of Atlantic Salmon Report and offered to meet in early 2018

Key Questions and Issues Raised	**Where Addressed in the EIS**
None identified to Proponent	n/a

Siepkne'katik First Nation		
Date	**Engagement Activity**	**Purpose**
July 14, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge
November 22, 2017	Letter (Received)	Expressed interest in discussing possible Project effects on fish and fish habitat specific to commercial fisheries species, Food Social Ceremonial species and species at risk. Indicated that as more Project information becomes available, additional concerns may be identified.
December 1, 2017	Telephone Discussion	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen. Discussion of Project, potential effects on Atlantic salmon, eel, swordfish, including possible oil spills. Wish to receive and review salmon migration report, and participate in future discussions.
December 12, 2017	Nexen	Acknowledged Chief Sack's letter dated Nov. 22/17 and provided a copy of the Atlantic Salmon Report.

Key Questions and Issues Raised	**Where Addressed in the EIS**
EA review processes and associated engagement procedures	Section 1.3.1, 3.0
Atlantic salmon migrations and potential effects	Section 3.3, 6.1.8, 8.4.4, 12.3
Potential effects on American eel	Section 8.4.5, 12.3
FSC and commercial fisheries and possible effects on these	Section 7.4, 12.3
Potential oil spills and their effects	Section 16.0
Swordfish / fisheries and possible effects on these	Section 7.4, 12.3

3.3.5 New Brunswick Indigenous Groups

A summary of engagement initiatives with the various New Brunswick Indigenous groups identified earlier is provided in Table 3.8, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.8 Engagement Activities with New Brunswick Indigenous Groups and Key Outcomes

Mi'gmawe'l Tplu'taqnn Inc. (MTI)

Aggregate body for Pabineau First Nation, Esgenoopetitj First Nation, Buctouche First Nation, Indian Island First Nation, Eel River Bar First Nation, Metepenagiag Mi'kmaq Nation, Fort Folly First Nation, and Eel Ground First Nation with regards to engagement. For any engagement with MTI, Nexen understands that MTI is acting on behalf of the groups listed above.

Date	Engagement Activity	Purpose
July 17, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
July 31, 2017	MTI Email	MTI acknowledge receipt of introductory letter and propose dates to meet.
August 16, 2017	Telephone Discussion	Meeting by telephone to discuss Project
August 16, 2017	Nexen Email	Nexen follow-up to requests from meeting.
October 13, 2017	Telephone Discussion	Updating Nexen contact information and need to follow up on requests for participant funding.
November 28, 2017	Telephone Discussion	Confirmed receipt of previous correspondence. Concerns about potential effects on Atlantic salmon, discussion of potential pre-EIS meetings, awaiting response to funding request.
December 12, 2017	Nexen Letter	Provided a copy of the Atlantic Salmon Report, acknowledged request for participant funding and offered to meet in January 2018.

Key Questions and Issues Raised	Where Addressed in the EIS
EA review processes and associated engagement procedures / funding	Section 1.3.1, 3.0
Atlantic salmon migrations and potential effects	Section 3.3, 6.1.8, 8.4.4, 12.3

Elsipogtog First Nation

Date	Engagement Activity	Purpose
July 14, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge.
November 30, 2017	Nexen Email	Nexen representative contacted Kopit Lodge by email to request telephone meeting.
December 13, 2017	Elsipogtog Email	Response from representative of Kopit Lodge/Elsipogtog, requesting follow-up phone call with Nexen representative.
January 16, 2018	Nexen Email	Provided a copy of the Atlantic Salmon Report

Key Questions and Issues Raised	Where Addressed in the EIS
None identified to Proponent	n/a

Wolastoqey Nation of New Brunswick (WNNB)

Aggregate body for Kingsclear First Nation, Madawaska Maliseet First Nation, Oromocto First Nation, Saint Mary's First Nation, and Tobique First Nation with regards to engagement. For any engagement with WNNB, Nexen understands that WNNB is acting on behalf of the groups listed above

Date	Engagement Activity	Purpose
July 17, 2017	Nexen Email	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge (sent individually to all members of WNNB, cc: WNNB).
November 29, 2017	Nexen Telephone Call	Confirmation that previous correspondence was received. WNNB reiterated need to not only consider "resource use" but also cultural value, including potential effects on migrating salmon and implications for cultural practices. Do not require additional copy of salmon report. Will participate in the EA review through the CEAA (crown) process.

Key Questions and Issues Raised	Where Addressed in the EIS
EA review processes and associated engagement procedures	Section 1.3.1, 3.0
Atlantic salmon migrations and potential effects	Section 3.3, 6.1.8, 8.4.4, 12.3
Need to consider cultural value, including potential effects on cultural practices	Section 7.4, 12.2, 12.3

Kingsclear First Nation, Madawaska Maliseet First Nation, Oromocto First Nation, Saint Mary's First Nation, and Tobique First Nation

Date	Engagement Activity	Purpose
July 17, 2017	Nexen Email (Letters)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letters)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge.

Key Questions and Issues Raised	Where Addressed in the EIS
None identified to Proponent	n/a

Woodstock First Nation

Date	Engagement Activity	Purpose
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge.
November 30, 2017	Nexen Email (Letter)	Request for meeting to discuss Project
December 1, 2017	Nexen Email	Follow-up, request for meeting to discuss Project
December 5-6, 2017	Email / Telephone Call	Follow-up, request for meeting to discuss Project
December 18, 2017	Woodstock Telephone Call	Woodstock requested follow-up by telephone in early January 2018.

Key Questions and Issues Raised	Where Addressed in the EIS
None identified to Proponent	n/a

Peskotomuhkati Nation at Skutik (Passamaquoddy)		
Date	**Engagement Activity**	**Purpose**
July 31, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge
November 30, 2017	Nexen Email	Nexen representative followed up to confirm receipt of previous correspondence, level of interest in the Project, preliminary concerns, interest in meeting with Nexen
December 1, 2017	Nexen Telephone Call	Made appointment for telephone meeting
December 11, 2017	Telephone Meeting	Discussion of Project, and lack of capacity to address engagement requests. Questions about Nexen as a company, concerns over possible effects on salmon and possibly other species, request to provide salmon report and possible further discussion in new year.
January 16, 2018	Nexen Email	Provided a copy of the Atlantic Salmon Report
Key Questions and Issues Raised		**Where Addressed in the EIS**
Nexen corporate overview		Section 1.1
Engagement processes and capacity issues		Section 1.3.1, 3.0
Potential effects on Atlantic salmon		Section 3.3, 6.1.8, 8.4.4, 12.3

3.3.6 Prince Edward Island Indigenous Groups

A summary of engagement initiatives with the various Prince Edward Island Indigenous groups identified earlier is provided in Table 3.9, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.9 Engagement Activities with Prince Edward Island Indigenous Groups and Key Outcomes

Mi'kmaq Confederacy of Prince Edward Island (MCPEI) Aggregate body for the Abegweit First Nation and Lennox Island First Nation with regard to engagement.		
Date	**Engagement Activity**	**Purpose**
July 17, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge.
November 29, 2017	Nexen Email and Telephone Call	Follow-up to initial correspondence
December 4, 2017	MCPEI Letter (Received)	Defer to Indigenous peoples of NL with regard to the Project. Need to ensure that proper engagement protocols are followed, and note that there may be relevant Indigenous knowledge related to this Project and its potential effects.

Mi'kmaq Confederacy of Prince Edward Island (MCPEI) Aggregate body for the Abegweit First Nation and Lennox Island First Nation with regard to engagement.		
December 5, 2017	Email and Telephone Call	Follow-up to initial correspondence
December 18, 2017	Nexen Letter	Acknowledged MCPEI letter of December 4, 2017.
Key Questions and Issues Raised		**Where Addressed in the EIS**
Indigenous groups / interests and engagement protocols		Section 3.3, 7.4, 12.0
Indigenous knowledge		Section 3.3.2

Abegweit First Nation and Lennox Island First Nation		
Date	**Engagement Activity**	**Purpose**
July 17, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
Key Questions and Issues Raised		**Where Addressed in the EIS**
None identified to Proponent		n/a

3.3.7 Quebec Indigenous Groups

A summary of engagement initiatives with the various Quebec Indigenous groups identified earlier is provided in Table 3.10, as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.10 Engagement Activities with Quebec Indigenous Groups and Key Outcomes

Mi'gmawei Mawiomi Secretariat (MMS) Aggregate body for Micmas of Gesgapegiag, La Nation Micmac de Gespeg and Listuguj Mi'gmaq Government with regards to engagement. For any engagement with MMS, Nexen understands that MMS is acting on behalf of the groups listed above		
Date	**Engagement Activity**	**Purpose**
July 17, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge.
November 30, 2017	Nexen Telephone Call	Follow-up to initial correspondence (left message)
December 1, 2017	Nexen Email	Follow-up to initial correspondence, request for telephone meeting
Key Questions and Issues Raised		**Where Addressed in the EIS**
None identified to Proponent		n/a

Les Innus de Ekuanitshit		
Date	**Engagement Activity**	**Purpose**
July 17, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge.
December 1, 2017	Nexen Telephone Call	Follow-up to initial correspondence
December 5, 2017	Nexen Telephone Call	Follow-up to initial correspondence
Key Questions and Issues Raised		**Where Addressed in the EIS**
None identified to Proponent		n/a

Montagnais de Nutashkuan		
Date	**Engagement Activity**	**Purpose**
July 17, 2017	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
November 9, 2017	Nexen Email (Letter)	Follow-up to initial correspondence, re-iterating availability to discuss Project and any concerns, requesting existing information on relevant land use or Indigenous knowledge.
December 1, 2017	Nexen Telephone Call	Follow-up to initial correspondence
December 5, 2017	Nexen Telephone Call	Follow-up to initial correspondence, request to re-send original correspondence
Key Questions and Issues Raised		**Where Addressed in the EIS**
None identified to Proponent		n/a

3.3.8 Planned Future Engagement with Indigenous Groups

As described in Section 12.5, Nexen will continue to communicate with Indigenous groups about the Project, through established and/or informal engagement processes, as required and requested. These will be undertaken to provide Project information and updates on on-going and planned activities, as requested, as well as to facilitate discussion of any issues and potential means of addressing them during the various phases of this Project and any Project-related monitoring and/or follow-up, as required. The specific nature, frequency and format of any such future engagement will be determined in discussion with the Indigenous groups themselves.

3.4 Stakeholder Organizations

As part of EIS planning and development, Nexen designed and implemented a stakeholder engagement program which provides various mechanisms and opportunities for individuals and organizations to receive and review information as well as to provide information and feedback related to the Project and its potential effects.

Nexen has utilized a variety of engagement approaches and methods to ensure that all interested parties have full opportunity to participate in the EA process for the Project. As shown in Table 3.11 below, these have included meetings with individual community and stakeholder groups, as well as additional discussions and on-going information sharing through various other means (such as through letters, email, telephone conversations), the results of which have also been considered in the scope and content of the EIS as applicable. A key aspect of the communications program is to provide those interested in the Project with a range of sources of information and platforms to encourage discussion and education and provide feedback regarding the Project.

The focus of these engagement activities has been obtaining and recording information and input related to:

- Questions, issues or comments regarding the Project and its potential environmental effects;
- Suggestions for means by which the feedback received can be incorporated into Project planning and decisions/actions; and
- Local knowledge regarding the existing biophysical and socioeconomic environments in and around the Project Area.

As part of EIS preparation, Nexen has met or communicated directly with a number of groups to share information on the Project and to identify questions or concerns that may require consideration in the EA process. Groups initially identified and contacted by Nexen were those that are known to have an interest in offshore oil and gas activities off Eastern Newfoundland and who have participated in similar, recent EA reviews for such projects in the region, with additional groups also being identified as the stakeholder engagement program progressed.

A summary of Project related engagement initiatives involving stakeholder groups is provided in Table 3.11 (to January 19, 2018). as well as an overview of the key questions and issues raised and where these are addressed in this EIS.

Table 3.11 Meetings and Discussions with Stakeholder Organizations and Key Outcomes

Date	Organization	Type/Format	Topic
May 2, 2016	Newfoundland and Labrador Offshore Oil and Gas industries Association (NOIA)	Meeting	Introduction to Nexen and senior management; overview of planned activities
February 28, 2017	One Ocean	Meeting	Overview of Nexen and the Project, EA review process, and One Ocean organization and its role.

Date	Organization	Type/Format	Topic
			Discussion of key fisheries in the area, potential effects, and mitigations (especially, fisheries consultation and communications protocols).
March 2, 2017	Fish, Food and Allied Workers Union (FFAW-Unifor)	Meeting	Overview of Nexen and the Project, discussion of regulatory review processes, potential Project-related effects on (interference with) commercial fisheries, mitigations (communications and FLOs), fisheries data to be used in the EIS.
March 9, 2017	Fish, Food and Allied Workers Union (FFAW-Unifor)	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Association of Seafood Producers	Nexen Email	Introduction to Project (including Project Overview document)
March 9, 2017	Canadian Association of Prawn Producers	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Groundfish Enterprise Allocation Council	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	NL Aquaculture Industry Association	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Atlantic Shark Association	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Nova Scotia Swordfish Association	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Clearwater Seafoods	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Harbour Grace Shrimp Company	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Icewater Seafoods	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Nataaqnaq Fisheries Inc	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Netukulimk Fisheries Limited	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Newfound Resources Ltd.	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Ocean Choice International (OCI)	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Seafreez Foods Inc. (Barry Group Inc.)	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Davis Strait Fisheries	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	MV Osprey Ltd.	Nexen Email (Letter)	Introduction to Project (including Project Overview document)

Date	Organization	Type/Format	Topic
March 9, 2017	Sambro Fisheries	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Nature NL	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Canadian Parks and Wilderness Society (CPAWS)	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	World Wildlife Fund (WWF) Canada	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	Protected Areas Association of NL	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 9, 2017	NL Wildlife Federation	Nexen Email (Letter)	Introduction to Project (including Project Overview document)
March 21, 2017	Nalcor Energy	Meeting	Discussion of Nexen and its past and proposed oil and gas activities
March 22, 2017	Newfoundland and Labrador Oil and Gas Industries Association (NOIA)	Meeting	Discussion of Nexen and its past and proposed oil and gas activities, as well as socioeconomic benefits of exploration programs such as this Project
March 22, 2017	Husky Energy	Meeting	Discussion of Nexen and its past and proposed oil and gas activities
April 28, 2017	Nature NL	Nature NL Email (Received)	Response to Nexen email and Project Overview, raised issues related to potential presence of and effects on cold water corals, possible effects on marine birds (esp. lights) and marine mammals.
December 1, 2017	One Ocean	Telephone Discussion	Project and EA update
December 1, 2017	Ocean Choice International	Telephone Discussion	Project and EA update
December 4, 2017	Northern Peninsula (Mekap'sk) Mi'kmaq Band	Northern Peninsula Band Letter (Received)	Potential effects on group's activities and interests, including subsistence and commercial fishing. Possible effects of drilling activities, use of seismic / sonar and oil spills
December 16, 2017	Northern Peninsula (Mekap'sk) Mi'kmaq Band	Nexen Letter	Acknowledged December 4, 2017 letter
January 16, 2018	Flat Bay Band	Flat Bay Band Letter (Received)	Potential effects on group's activities and interests, including subsistence and commercial fishing. Possible effects of drilling activities, use of seismic / sonar and oil spills
January 17, 2018	FFAW-Unifor	Meeting	Project and EA update

Key Questions and Issues Raised	Where Addressed in the EIS
Key commercial fisheries in and near the Project Area, and potential interference with these	Section 7.2, 13.0
Fisheries related mitigation requirements, especially FLOs and on-going communications throughout the Project	Section 13.3.2
Fisheries baseline data to be used in the EIS	Section 7.2
Socioeconomic benefits of offshore oil and gas exploration activities	Section 2.2
Presence of and possible effects on cold water corals	Section 6.1.6, 8.3
Offshore lighting and its effects on marine avifauna	Section 9.3
Marine mammals and possible effects on these species	Section 10.0
Possible environmental effects of drilling and VSP (seismic) / sonar activities	Section 2.5.2, 8.3.5, 9.3.5, 10.3.5, 11.3, 12.3, 13.3.5
Potential environmental effects of an oil spill event	Section 16.6
Location of and schedule for planned Project components and activities	Section 2.5, 2.7
Drilling methods and equipment	Section 2.5.2
Light, noise, and vibration reduction measures for drilling activities	Section 2.9
Spill-prevention equipment and measures	Section 16.1
Oil spill notification and commination protocols	Section 16.1, 16.6.7, 18.4

4 ENVIRONMENTAL ASSESSMENT SCOPE, FOCUS AND APPROACH

As described in Section 1.3, the Project requires review and approval pursuant to the requirements of CEAA 2012, as it has been determined to constitute a "designated project" under the associated *Regulations Designating Physical Activities*. The EA review of the Project under CEAA 2012 commenced in April 2017 with Nexen's submission of a Project Description and associated Summary Documents to the Agency, which were subsequently made available for governmental and public review. Following that review period, on June 9, 2017 the Agency determined that a federal EA was required for the Project and issued the associated Notices of EA Determination and EA Commencement, as well as Draft EIS Guidelines, which were subsequently finalized and issued to Nexen on July 25, 2017.

This EIS has been planned, prepared and submitted by Nexen in accordance with requirements of CEAA 2012 as well as the Project-specific EIS Guidelines and other generic EA guidance documents issued by the Agency as cited herein.

This chapter outlines the scope and focus of the EIS, as well as describing the approach and methods that have been used to conduct the assessment. This is followed (in Chapters 5-7) by a description of the existing environment within the Project Area and associated EA Study Areas, which forms the environmental baseline for the eventual prediction and evaluation of the Project's potential environmental effects and the associated identification of mitigation. Based on this EA scope and using the methodology outlined in this chapter, this has included assessing the potential environmental effects of the Project's planned components and activities (Chapters 8-14), any cumulative environmental effects that the Project and its residual effects may contribute to (Chapter 15), and the environmental effects of any potential accidental events that may be associated with the Project (Chapter 16).

4.1 Scope of the Environmental Assessment and Factors Considered

The scope of the Project for the purposes of the EA includes each of the components and activities defined in Part 1, Section 3.1 of the EIS Guidelines and described in Chapter 2 of this EIS, namely:

- *The mobilization, operation and demobilization of Mobile Offshore Drilling Unit(s) designed for year-round operations for the drilling, testing and abandonment of up to ten wells (exploration or delineation) within exploration licences operated by Nexen Energy ULC (1144 and 1150), including consideration of any proposed safety exclusion zones. Drilling may occur in various water depths under consideration, with various types of drilling units, and with multiple drilling units operating simultaneously;*

- *Vertical seismic profiling surveys and in -water works (e.g. well evaluation and testing) to support the specific exploration wells under consideration, but excluding surveys potentially required to support conduct of the EA (e.g. environmental baseline surveys) and surveys related to the broader delineation of resources (e.g. use of 2D high-resolution reflection seismic, sub-bottom profilers, side-scan sonar, multi-beam echosounder, magnetometers); and*

- *The loading, refuelling and operation of marine support vessels (i.e. for re-supply and transfer of materials, fuel, and equipment; on-site safety during drilling activities; and transport between the supply base and Mobile Offshore Drilling Unit(s)) and helicopter support (i.e. for crew*

transport and delivery of light supplies and equipment) including transportation to the Mobile Offshore Drilling Unit(s).

The conduct of the proposed offshore oil and gas exploration activities that comprise the Project have the potential to interact with, and result in associated changes and effects to, a number of environmental components. CEAA 2012 includes the following definitions and specifications related to assessing the environmental effects of a designated project, which are relevant to the overall scope of the assessment, and which have guided the planning and development of the EIS:

[E]nvironment means the components of the Earth, and includes
(a) land, water and air, including all layers of the atmosphere;
(b) all organic and inorganic matter and living organisms; and
(c) the interacting natural systems that include components referred to in paragraphs (a) and (b)

5 (1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are
(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:
(i) fish and fish habitat as defined in subsection 2(1) of the Fisheries Act,
(ii) aquatic species as defined in subsection 2(1) of the Species at Risk Act,
(iii) migratory birds as defined in subsection 2(1) of the Migratory Birds Convention Act, 1994, and
(iv) any other component of the environment that is set out in Schedule 2;
(b) a change that may be caused to the environment that would occur
(i) on federal lands,
(ii) in a province other than the one in which the act or thing is done or where the physical activity, the designated project or the project is being carried out, or
(iii) outside Canada; and
(c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on
(i) health and socio-economic conditions,
(ii) physical and cultural heritage,
(iii) the current use of lands and resources for traditional purposes, or
(iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

In addition, a number of other types of environmental effects must be considered under Section 5(2) of CEAA 2012 where the carrying out of the physical activity, the designated project or the project requires a federal authority to exercise a power or perform a duty or function conferred on it under any other Act of Parliament. In the case of this Project, and as described in Sections 1.3 and 1.5, Nexen will require authorizations from the C-NLOPB under the Accord Acts and possibly from other federal authorities in order for the Project to proceed (Section 18.5). Therefore, the following environmental effects are also taken into account in the EIS:

(a) a change, other than those referred to in paragraphs (1)(a) and (b), that may be caused to the environment and that is directly linked or necessarily incidental to a federal authority's

> *exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the physical activity, the designated project or the project; and*
>
> *(b) an effect, other than those referred to in paragraph (1)(c), of any change referred to in paragraph (a) on*
>
> *(i) health and socio-economic conditions,*
> *(ii) physical and cultural heritage, or*
> *(iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.*

As defined in Section 19(1) of CEAA 2012 and specified in Section 3.2 of the EIS Guidelines, the following factors are considered and addressed in the EIS:

- Environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other physical activities that have been or will be carried out;
- The significance of the effects referred to above;
- Comments from the public;
- Mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project;
- The requirements of the follow-up program in respect of the project;
- The purpose of the project;
- Alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;
- Any change to the project that may be caused by the environment; and
- The results of any relevant regional study pursuant to CEAA 2012.

These items have been considered and addressed in establishing the scope, focus, and spatial and temporal boundaries of the analysis and the overall content of the EIS, including the description of the Project (Chapter 2), the planning and implementation of any EA-related engagement activities by Nexen (Chapter 3), the description of the existing environments (Chapters 5-7) and in the environmental effects assessments (Chapters 8-14).

The EIS has again also been planned, completed and submitted in compliance with the Project-specific EIS Guidelines issued to Nexen by the Agency, which outline the factors to be considered in the assessment and the scope of those factors, as well as specifying particular requirements for environmental information and analysis that must be included in the EIS. A detailed Table of Concordance that outlines these requirements and indicates where and how each of them have been addressed in the EIS was provided at the beginning of the EIS.

4.2 Identification of Valued Components

The early, appropriate scoping of an EA is considered essential to help ensure that the assessment identifies the key environmental components and issues of concern. It should therefore focus on those components that are likely to be affected, and which are most relevant to governmental, Indigenous, stakeholder and public concerns and interests, and thus, to eventual regulatory decisions.

For this reason, EAs typically identify and focus on aspects of the environment that are of particular ecological or socioeconomic importance and/or which can serve as indicators of environmental change, and which have the potential to be materially affected in some way by the proposed project under assessment. These are known as Valued Components (VCs), and may include both biophysical and human aspects of the environment. The VC approach is a useful, effective and widely accepted way of helping to ensure that an EA focuses on important and relevant environmental components and issues, including those which are most relevant to eventual Project planning and decision-making.

For this EIS, the identification and selection of the particular VCs upon which it would focus was an early, on-going and iterative process based on a number of key considerations and inputs. These included relevant regulatory guidance including the EIS Guidelines, Nexen's engagement with government departments and agencies, Indigenous groups, fisheries organizations and other stakeholder groups and other interested parties (Chapter 3). . It was also ultimately informed by consideration of the overall nature and characteristics of the Project (Chapter 2), its existing environmental settings (Chapters 5-7), and the professional experience of the Proponent and EIS Study Team with similar projects and assessments and existing scientific literature (where available) regarding the known environmental effects of offshore exploration drilling and associated activities.

In keeping with most recent EAs for other oil and gas related exploration projects the following VCs are considered in this assessment:

a) Marine Fish and Fish Habitat (including Species at Risk);
b) Marine and Migratory Birds (including Species at Risk);
c) Marine Mammals and Sea Turtles (including Species at Risk);
d) Special Areas;
e) Indigenous Peoples;
f) Fisheries and Other Ocean Uses; and
g) Atmospheric Environment

The rationale for the selection of these VCs is further described in Table 4.1 below.

Table 4.1 Identified VCs and the Rationale for their Selection

Valued Component	Overview and Rationale
Marine Fish and Fish Habitat (including Species at Risk)	• Fish and their habitats are an important consideration in the EA of any proposed activities that occur within, and that may affect, the marine environment. • Consideration of fish and fish habitat is also required under Section 5 (1)(a) i) of CEAA 2012 • This VC includes relevant fish species (finfish and invertebrates), as well as marine plants, plankton, algae, benthos and relevant components of their habitats (such as water and sediment), given the clear interrelationships between these environmental components. • The consideration of marine fish and fish habitat within a single VC is in keeping with current and standard practice, and provides for a more comprehensive, holistic assessment approach while at the same time reducing unnecessary repetition. • Offshore oil and gas exploration drilling and associated activities may affect fish and fish habitat through their associated environmental disturbances (noise, light, others) and resulting behavioral effects, as well as through possible environmental emissions leading to changes

Valued Component	Overview and Rationale
	in water quality and the contamination, smothering or other alteration of marine habitats and benthic organisms due to physical disturbance of the substrate, the discharge and deposition of drill cuttings and/or fluids, or other solid and liquid wastes. • The VC (description of the existing environment and effects assessment) also gives specific consideration to any particular species that have been identified by regulatory agencies, stakeholder groups and Indigenous communities (Chapter 3).
Marine and Migratory Birds (including Species at Risk)	• A variety of avifauna species inhabit the marine and coastal environments off Eastern Newfoundland at various times of the year. • Birds are important from an ecological, social and economic perspective, as they often function near the top of the food chain, and may be relatively vulnerable to certain types of environmental disturbance. • They are also an important resource for recreational and tourism related pursuits. • Consideration of migratory birds is also required under Section 5 (1)(a) iii) of CEAA 2012. • Marine-associated birds may be affected by offshore exploration activities as a result of attraction and disturbance/disorientation due to lighting or other disturbances (leading to potential injury or mortality), as well as through possible health effects due to contamination of individuals and/or their habitats from emissions to the marine environment. • The VC (description of the existing environment and effects assessment) also gives specific consideration to any particular species that have been identified by regulatory agencies, stakeholder groups and Indigenous communities (Chapter 3).
Marine Mammals and Sea Turtles (including Species at Risk)	• Whales, dolphins and seals have been and remain an important element of the environmental and socio-cultural settings of the province and elsewhere in Eastern Canada. • Consideration of these species is also required under Section 5 (1)(a) ii) of CEAA 2012. • These species are important from an ecological perspective, with a number of species having been designated as species at risk under Canadian legislation or other processes. • Some marine mammal species are also important and valued due to current consumptive (seal harvests) and non-consumptive (whale watching) uses, which are important commercial, traditional and/or recreational activities in some areas. • Although sea turtles are generally uncommon off Eastern Newfoundland, they are also typically included as part of this VC given their rare and often protected status. • Offshore exploration drilling and associated activities may affect these marine biota through underwater noise and other disturbances leading to associated behavioral effects, as well as environmental emissions leading to possible health effects through contamination of individuals, habitats and prey species. • The VC (description of the existing environment and effects assessment) also gives specific consideration to any particular species that have been identified by regulatory agencies, stakeholder groups and Indigenous communities (Chapter 3).

Valued Component	Overview and Rationale
Special Areas	• Several locations within and off Eastern Newfoundland have been designated as protected under provincial, federal and/or other legislation and processes, due to their ecological, historical and/or socio-cultural characteristics and importance. • Some of these areas are protected under provincial and/or federal legislation and others are protected under international agreements and processes. • In addition to areas that have existing and formal protections, a number of other locations have been identified as being especially sensitive to possible environmental disturbances, including some that are important ecologically and/or for associated human activities and values. • Environmental interactions between petroleum activities and special areas may be both direct and indirect in nature and cause, and may result from conducting an activity directly within or near such an area, and/or by adversely affecting the larger environmental components and systems that are relevant to their identification and their key and relevant characteristics and importance.
Indigenous Peoples	• A number of Indigenous groups reside in Newfoundland and Labrador and in parts of the Maritimes Provinces (Nova Scotia, New Brunswick, PEI) and Quebec. • The proposed components and activities that comprise this offshore Project will be located at considerable distance from the communities, activities and other known interests associated with Indigenous groups (see Section 7.4 and Chapter 12). • It may, however, potentially affect marine-associated species and other resources that are used by these groups, and which move through, and thus may interact with, the Project's anticipated environmental zone of influence • This VC has been included in the EIS in order to assess the potential for the Project to interact with and affect Indigenous Peoples, as required under Section 5(1)(c) of CEAA 2012 and as specified in the EIS Guidelines.
Fisheries and Other Ocean Uses	• Marine fisheries are key elements that have shaped the history and socioeconomic character of Newfoundland and Labrador and are important aspects of the current economic and socio-cultural fabrics of the province and other parts of Canada. • As noted in the existing data (Section 7.2) and through Nexen's engagement with fishing industry representatives (Section 3.4) commercial fisheries in this region are extensive and diverse, and involve a range of species and gear types at various times of the year. Fishing activities are undertaken in and around the Project Area by fishing interests from Newfoundland and Labrador (including several Indigenous organizations), Canadian and international fishing enterprises • Other activities take place in parts of the Project Area and adjacent areas on either a year-round or seasonal basis, including other oil and gas related activities, general vessel traffic, research, and military exercises. • These and other marine uses and users may be affected both directly (through possible interactions and disturbance) and indirectly (due to any negative changes in the biophysical environment). • Potential effects on commercial fisheries and associated mitigation were raised during Nexen's engagement processes with multiple groups (Section 3.0)

Valued Component	Overview and Rationale
Atmospheric Environment	• Atmospheric emissions during Project activities will include exhaust from the drill unit(s), support vessels and associated equipment (such as on-board power generators), as well as emissions from the storage and flaring of hydrocarbons associated with well testing (if and as required). • Noise emissions into the atmospheric environment associated with an offshore drilling program include those associated with drilling and other activities on the MODU itself, as well as from supporting vessel and aircraft traffic. • Light emissions from the drilling platform include platform lighting as well as those which may be associated with any flaring that is required during well testing operations and that generated by the support vessels.

Related to the above three biophysical VCs (marine fish and fish habitat, marine and migratory birds, marine mammals and sea turtles), the environmental effects assessments consider species that are secure as well as those listed under SARA as species at risk or identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as species of conservation concern. These species are identified and their known or likely presence, abundance and geographic and temporal distribution is described in an integrated manner under the existing environment sections for each of the above components, as well as in the environmental effects assessment for each of these VCs. Within these VC Chapters these species at risk are, however, given special attention and emphasis in the identification, analysis and evaluation of potential environmental effects and any required mitigation measures.

Table 4.2 links each of these identified VCs to the various environmental components and issues that are specified under CEAA 2012 (Section 5).

Table 4.2 Identified VCs and Potential Considerations Relevant to CEAA (2012)

Environmental Component or Issue	Relevant Section(s) of CEAA 2012	Valued Components						
		Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
Fish, Fish Habitat, and Aquatic Species	5(1)(a)(i) 5(1)(a)(ii)	●		●	◆	◆	◆	
Migratory Birds	5(1)(a)(iii)		●		◆	◆		
Project Activities Occurring on Federal Lands	5(1)(b)(i)	●	●	●	●	●	●	●
Transboundary Issues [1]	5(1)(b)(ii)	●	●	●	●		●	●

Environmental Component or Issue	Relevant Section(s) of CEAA 2012	Valued Components						
		Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
Health and Socio-Economic Conditions for Aboriginal and Non-Aboriginal People	5(1)(c)(i) 5(2)(b)(i)	◆	◆	◆	◆	●	●	
Physical and Cultural Heritage, or Resources of Historical, Archaeological, Paleontological, or Architectural Significance	5(1)(c)(ii) 5(1)(c)(iv) 5(2)(b)(ii) 5(2)(b)(iii)					●		
Current Use of Lands and Resources for Traditional Purposes by Aboriginal Groups	5(1)(c)(iii)	◆	◆	◆		●		
Other Changes to the Environment Directly Related or Necessarily Incidental to a Federal Authority's Exercise of a Power or Performance of a Duty or Function in Support of the Project	5(2)(a)							●

NOTE: ● Represents a direct relationship while ◆indicates an indirect relationship.

[1] Planned Project activities that take place within the area of Canada's jurisdiction are not anticipated to result in environmental changes and direct interactions that will extend to the environment outside Newfoundland and Labrador or outside the marine waters under the jurisdiction of Canada. The Project may, however, affect environmental components (such as migratory fish, aquatic species, or birds) that extend to and/or move both within and outside the areas under the jurisdiction of Canada. In addition, Project activities or disturbances that occurring within areas of international jurisdiction (such as NAFO designated special areas or in locations where international fishing or other marine activities are taking place), has the potential to affect these components and activities. Also, any accidental event such as a large scale oil spill could extend to other provinces of Canada or outside an area of Canada's jurisdiction.

Although the EIS provides individual environmental effects assessments for each VC (Chapter 8 to 14), it is done with full consideration of the interactions and interrelationships between these environmental components through a holistic, ecosystem based approach. As required in the EIS Guidelines, the chapters that follow also discuss and consider other relevant regulatory, administrative and policy contexts for each VC as part of the analysis and description of existing environment and in the analysis, mitigation and evaluation of environmental effects as applicable.

In summary, the identification of the overall VCs upon which the EIS has focused, and the consideration of and relative emphasis on each of the various sub-components that comprise each of these VCs in the effects analyses, has been informed by the specific issues and concerns raised by government agencies, stakeholder organizations, and Indigenous groups that have participated in the various

engagement activities outlined in Chapter 3. In the latter case, VC selection involved the consideration of available information and perspectives from Indigenous communities regarding their activities and interests in respect of the potentially affected environment. This includes inputs received from each group through direct engagement (Chapter 3) and/or as reflected in available information on the community and its activities.

Section 6.3.8.4 of the EIS Guidelines also identify the "Human Environment" as a potential VC, and lists various associated socioeconomic components for inclusion. Although not considered a separate VC for the environmental effects assessment, relevant aspects of the human environment that are listed in this section of the EIS Guidelines and which have the potential to be affected by the Project are considered and addressed as part of the other socioeconomic VCs identified above. This includes other commercial and recreational ocean users, physical heritage items such as shipwrecks, and other components that are required to be considered in the EIS under relevant provisions of CEAA 2012 (such as, for Indigenous Peoples, those factors required under Section 5(1)(c) of the Act). Human health is considered within those VCs to the extent that it may be affected by the Project's planned activities or unplanned events, such as through direct interaction with fishing activities and equipment or through resource tainting in the event of a spill. However, given the location of most Project components and activities far offshore (and thus, over 400 km from any communities or on-land human activities), adverse effects on other aspects of human health are not anticipated. Similarly, given the nature and location of the Project, adverse effects on other components of the human environment, such as on-land or nearshore aspects of physical and cultural heritage, rural and urban settings, and other aspects of existing socioeconomic conditions in Eastern Newfoundland and beyond are not anticipated, and so these are not considered specifically as a VC in the EIS.

A general overview of these aspects of the existing human environment in Eastern Newfoundland is, however, provided in Section 7.1 of this EIS, as background information for the assessment.

4.3 Environmental Effects Assessment (Planned Project Components and Activities)

The following sections describe the EA approach and methodology that have been used to conduct the environmental effects assessments presented in this EIS, including each of their key stages and components. The structure and methods used are in keeping with current EA approaches and practice in Canada, including under CEAA 2012, and have been developed and applied to help ensure a thorough and rigorous analysis, while also presenting the results of the assessment in a clear, concise and well-organized manner.

As specified in Part 1, Section 4.3 of the EIS Guidelines, the EA approach and methodology addresses each of the following general items:

- Identifying the activities and components of the project;
- Predicting potential changes to the environment;
- Predicting and evaluating the likely effects on identified VCs;
- Identifying technically and economically feasible mitigation measures for any significant adverse environmental effects;
- Determining any residual environmental effects;
- Considering cumulative effects of the project in combination with other physical activities that have been or will be carried out; and

- Determining the potential significance of any residual environmental effect following the implementation of mitigation measures

A description of the Project was provided in Chapter 2, including its need, purpose and rationale and alternatives, as well as its planned location, main components and activities, and timing. The existing natural and human environmental settings for the Project are subsequently described in Chapters 5-7, including the key components of the environment that overlap, and may interact with, the Project. This includes detailed descriptions of existing environmental conditions for each of the VCs under consideration, as well as for a number of other components of the environment which are not VCs per se but which are specified in the EIS Guidelines and/or are relevant to certain aspects of the EA (including the physical environment, Chapter 5).

The description of the existing environment forms the environmental baseline from which Project-related environmental changes and associated effects are assessed and evaluated, including the corresponding identification and development of technically and economically feasible mitigation to avoid or reduce adverse effects. The assessment of potential environmental effects is therefore generally based on the approach of "overlaying" the Project onto its existing environment, in order to identify and describe whether, how and to what degree the "without Project" conditions for the identified VC may change as a result of the Project.

The environmental effects assessments for each VC are provided in Chapters 8-14 (for planned Project components and activities). These follow the EA methods and specific stages outlined below, with each step of the analysis completed and reported in its own individual sub-section.

4.3.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

4.3.1.1 Study Areas

EA Study Areas (spatial and temporal boundaries) have been established to direct and focus the environmental effects assessment for each VC. These study boundaries reflect both general principles and generic considerations, as well as, where required and applicable, recognizing and incorporating any VC-specific issues and requirements. This includes any key differences between these environmental components in terms of their overall characteristics, spatial and temporal distributions and movement patterns, and in the manner in which they may interact with and potentially be affected by the Project. Establishing the spatial and temporal boundaries for the EIS included consideration of relevant regulatory guidance, the results of Nexen's engagement with government departments and agencies, Indigenous and stakeholder groups and others, and was further informed by the nature, scale, timing and other characteristics of the Project, its existing environmental setting, and potential environmental interactions.

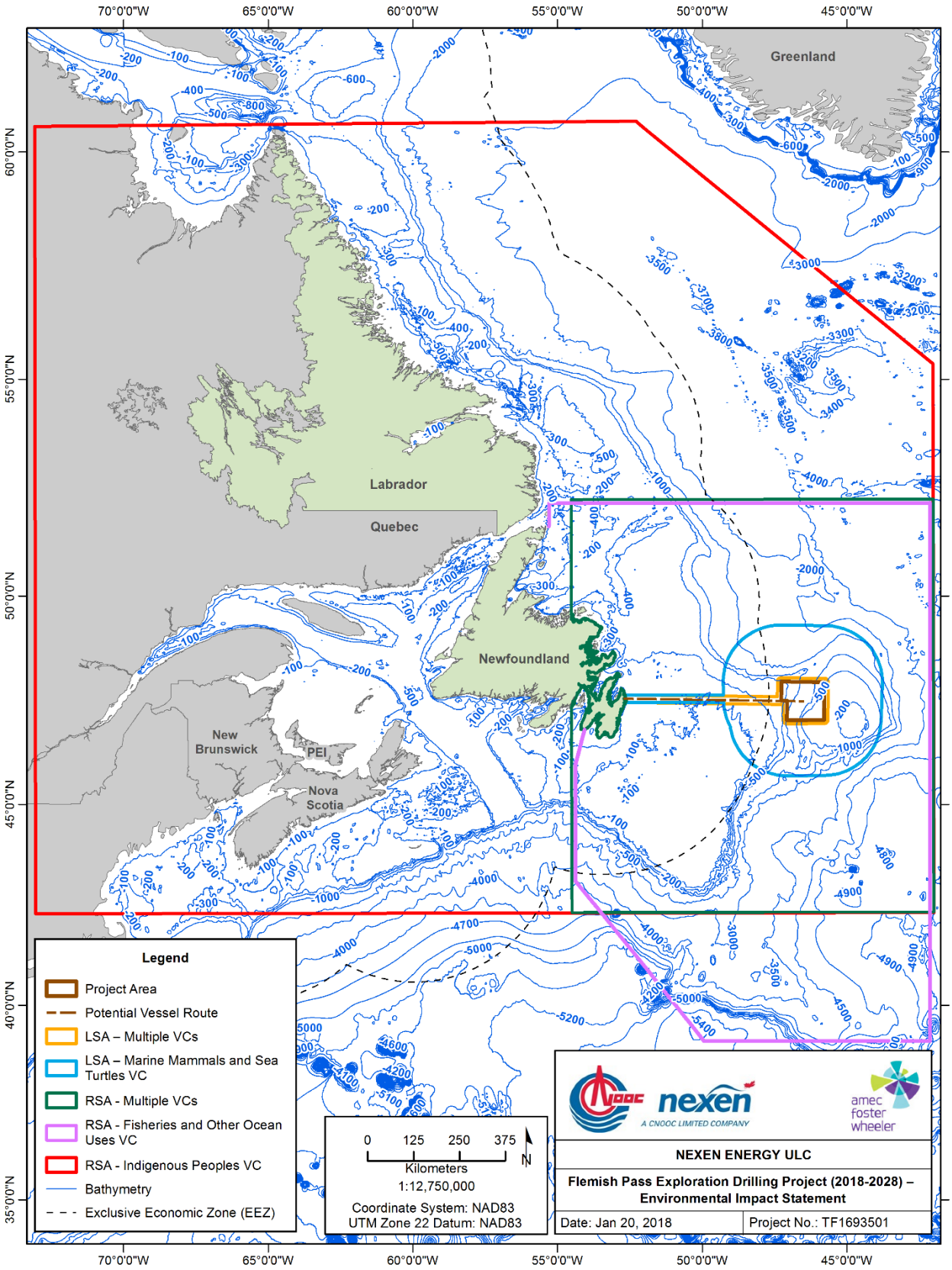
Three types of spatial assessment boundaries are defined (on a VC specific basis) and used in the EIS, which reflect the various ways and scales at which the Project may interact with and affect the environment (Table 4.3).

Table 4.3 Environmental Assessment Study Areas

Spatial Study Areas	Description
Project Area	• This is the overall geographic area within which all planned Project-related exploration activities will take place, as described in the Project Description (Chapter 2) and based on those aspects that are considered to be within the defined scope of the Project for EA purposes (Section 4.1). • As illustrated in Section 2.3, the Project Area is defined as a single polygon that encompasses the two ELs in the Flemish Pass region where Nexen is proposing to conduct exploration drilling activities, as well as including a surrounding (20 km buffer) area to account for planned and potential ancillary and support activities at and around the wellsites themselves. • The EIS also considers related supply vessel and aircraft traffic to and from this offshore Project Area. • It should be noted that while this overall Project Area covers an area of over 10,000 km^2 the various components and activities associated with the drilling of each individual well and other planned components will occupy small, defined areas within this overall area, as described in Chapter 2 and further illustrated in the VC specific environmental effects assessments presented in the chapters that follow. • All drilling operations carried out as part of the scope of this Project will be conducted within the defined boundaries of the ELs themselves.
Local Study Area (LSA)	• These boundaries are defined on a VC-specific basis, and encompass the overall geographic area over which all planned and routine Project-related environmental interactions (including emissions and other disturbances) may occur. • The LSA therefore represents the predicted environmental zone of influence of the Project's planned components and activities, within which Project-related environmental changes to the VC in question may occur and can be assessed and evaluated. • For each VC, the LSA will depend on the geographic extent of an environmental disturbance or change and may vary based on its specific nature, timing, or location. • Therefore, while the LSA for each VC has been defined to conservatively account for the overall zone of influence of potential Project activities at location within the Project Area, in some cases these environmental changes may occur only within a portion of the LSA itself. • To further address this, all predicted environmental effects are described in the effects assessment according to a number of criteria, which includes defining the anticipated "geographic extent" of any such effect (see Table 4.4 below).
Regional Study Area (RSA)	• In addition to planned Project environment interactions, from an ecological and socioeconomic perspective the environmental effects assessments also recognize and consider the characteristics, distributions, and movements of the individual VCs under consideration, including the larger regional areas within which they occur and function. • The EA assesses potential effects to marine biota (individuals and populations) and human activities which are known or likely to occur in the LSA for the VC in question, but also considers the overall extent of affected individuals and populations during the time period at which they may be affected by planned Project components and activities.

Spatial Study Areas	Description
	• Figure 4.1 illustrates the overall RSA that has been defined and used for most VCs in this EIS, which has been defined with consideration of a number of factors, as referenced above. • These include, for example, the possible movement patterns of the marine fish, birds, mammals, and sea turtles that occur in the respective LSAs for each VC over the time periods and durations for which they may be affected by planned Project activities (which may, in some cases extend up to several hundred kilometres), as well as a larger distribution and geographic extent of fishing and other human activities surrounding the Project Area/LSA for regional context purposes. • The RSA also encompasses the predicted zone of influence of a potential oil spill event, as summarized and assessed in Section 16.4 and modelled in detail in Appendix G, and specifically, the ecological and socioeconomic thresholds for the 95th percentile case for both surface (oil thickness) and water column exposure. The 95th percentile case is selected from 119 model runs that capture the seasonal and annual variability in currents, winds, and ice cover. • In doing so, the RSA extends west to the shoreline of Eastern Newfoundland and to the east to the general area for which available and validated environmental (including metocean and bathymetric) data are available, as well as reaching the eastern boundary of the various NAFO Divisions in this area. • It should be noted that this RSA has been defined and used as a general guide and area of focus for the environmental assessment, and represents the amalgamated consideration of each of the (quite diverse) VCs under consideration and the various factors noted above. The environmental effects assessment considers specific areas within this larger RSA as relevant and appropriate to the specific environmental component or interaction in question. • In addition, it likewise considers and describes environmental components and potential effects that may extend outside this area where relevant, based on the nature and coverage of the environmental baseline datasets and mapping used (see discussions at the beginning of Chapters 5, 6 and 7, for example). • As described in Section 12.1, the Indigenous Peoples VC considers the location and overall geographic extent of the various Indigenous communities and activities that comprise the VC, as well as the distribution and movements of the various marine-associated resources that are used for traditional purposes by these communities. For this VC, therefore, the RSA includes an overall region of Eastern Canada that generally encompasses each of the Indigenous communities and their activities throughout Newfoundland and Labrador, the Maritime Provinces and Quebec. • As described in Section 13.1, the RSA for the Fisheries and Other Ocean Uses VC generally captures the marine waters offshore Eastern Newfoundland, namely NAFO Divisions 3K, 3L, 3M, 3N and 3O.

Figure 4.1 Environmental Assessment Study Areas



The temporal boundaries for the EA encompass the potential timing and duration of Project-related activities and any resulting environmental changes and effects. The planned temporal scope of the Project covers a period from 2018 to 2028 with the planned exploration activities that comprise this Project possibly occurring at various times of (and throughout) the year for the duration of the proposed exploration program. In conducting the environmental effects assessment, consideration is also given to the relevant temporal characteristics of the VCs, including the timing of their presence within the Project Area and LSA/RSA, any particularly sensitive or critical periods, potential environmental interactions (both Project-specific and cumulative), likely response to and recovery times for potential effects, and any known natural (without-Project) variation in that environmental component over time.

It is within these spatial and temporal boundaries that the potential environmental effects on the VC resulting from Project components and activities and their significance are assessed and evaluated.

4.3.1.2 Significance Criteria

Evaluating the significance of the predicted residual environmental effects of a project is one of the most important steps in any EA, and is central to the practice of project EA in Canada and elsewhere. Doing so typically involves: 1) defining what a significant environmental effect is, and 2) on the basis of that definition, evaluating whether a project's potential environmental effects are significant or not significant.

The determination of significance under CEAA 2012 includes considering whether the predicted residual environmental effects of the Project are adverse, significant and likely. When a project is predicted to have adverse environmental effects, as defined in Section 5 of CEAA 2012, an EA examines whether the project is likely to cause significant adverse environmental effects after taking into account the implementation of technically and economically feasible mitigation measures. The determined significance of a project's potential environmental effects is then a primary consideration in eventual EA decisions by regulatory authorities about whether and how the project in question may proceed. In this EIS, the definition and determination of effects significance is based on the guidance provided in the Canadian Environmental Assessment Agency's Operational Policy Statement, *Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012* (Canadian Environmental Assessment Agency 2015).

Significance definitions are developed and used on a VC-specific basis within this EIS. Significant environmental effects are considered to be those adverse effects that will cause a change in the VC that will alter its status or integrity beyond an acceptable level. An environmental effect that does not meet the defined criteria is considered not significant. The development of the significance criteria used in this assessment includes consideration of (where available and relevant) any applicable legislation and regulations, standards, guidelines, objectives and/or policies and management plans relevant to such determinations.

For the biophysical VCs, the significance definitions include such factors as potential detectable declines in the overall abundance of marine biota or changes in their spatial and temporal distributions in the assessment areas over multiple generations, possible adverse effects to the overall abundance, distribution and health of a species at risk and its eventual recovery, and changes to the ecological and socio-cultural characteristics of special marine areas and thus to their overall integrity or value. For the socioeconomic VCs, significance is linked to the potential for, and degree and duration of, any

detectable effects on people and communities, including on the overall nature, location or timing of activities and their economic and cultural value, on people's health and well-being, and other relevant concepts and considerations as appropriate.

4.3.2 Potential Environmental Changes, Effects and Associated Parameters

In order to identify and focus on key environmental issues, and to help ensure that these are fully considered and addressed in the EIS, the effects assessment of each VC initially identifies the various questions and issues that have been raised with regard to the Project and its potential effects on the VC. This includes those that have been referenced in the EIS Guidelines, as well as those identified through Nexen's governmental, Indigenous and stakeholder engagement activities (as outlined in Chapter 3) and through other Project-related issues scoping initiatives.

The environmental effects assessment identifies and focuses on likely environmental interactions between the Project and the VC, and the associated environmental changes and resulting effects that may occur as result of these. Each VC assessment also identifies a number of associated parameters, which are generally defined as an important aspect or characteristic of the VC which, if changed as a result of the Project, may result in an adverse effect to the VC. For each VC, a summary of these potential interactions and associated parameters is presented in a table.

An overview of the identified potential interactions between the VC and each of the main Project components and activities is also provided (in table form) to focus and frame the environmental effects assessment

4.3.3 Environmental Effects Assessment and Mitigation

This section of each VC's effects assessment chapter provides the detailed analysis (prediction) and description of the potential environmental effects of the Project's planned components and activities on the VC in question. The environmental effects assessment considers the nature, degree, extent and timing of potential Project-induced change from the "without-Project" environment as a result of planned Project components and activities, and then, whether and how any such environmental changes will result in predicted environmental effects (through one or more pathways) on the VC in question. Although the EIS provides individual environmental effects assessments for each VC, this is done with full recognition and consideration of the key interactions and interrelationships between these environmental components and systems through a holistic, ecosystem based approach.

The environmental effects assessment for each VC evaluates the nature and degree of any changes to, and effects on, the existing (baseline) environment that will potentially occur with the introduction and conduct of the Project. The current condition of the pre-Project environment as a result of other natural and anthropogenic factors - and thus, its likely sensitivity or resiliency to further disturbance or change - has been integrally considered in the environmental effects analyses presented in this EIS. The assessment is also based on a recognition that environmental components and systems are not static, but rather are constantly changing over time both naturally and as a result of human activities and influences. These "without project" future environmental changes in the environmental baseline have also been considered in the assessment where possible and relevant, in particular those which are expected to occur within the temporal scope of the Project. Potential environmental changes that

may result from other future projects and activities within the LSA and RSA are also assessed as part of the cumulative effects analysis presented for each VC (Section 4.4).

Mitigation measures, as defined under CEAA 2012, means measures for the elimination, reduction or control of a project's potential adverse environmental effects. To help avoid or reduce the potential adverse effects of the Project, general and issue-specific mitigation measures are identified and proposed in this EIS based upon current industry practice and standards, applicable regulatory requirements, those suggested through Nexen's engagement with regulatory authorities, interested stakeholders and Indigenous groups (Chapter 3), and as defined through the professional judgment of the assessment team.

The application of mitigation measures is considered in an integrated manner in the environmental effects assessment. This includes technically and economically feasible measures that have been "built-in" to the Project through its planning and design, so as to avoid or reduce potential adverse environmental effects proactively (Chapter 2) as well as any other mitigation measures identified by the Proponent as part of the effects analysis that is reported herein. Where applicable, the EIS also discusses any cases where the implementation of identified mitigation may be the responsibility of parties other than Nexen or its contractors, as well as any cases where potential mitigation measures were considered and rejected, including the rationale for these decisions. Relevant information and findings from scientific literature, results of environmental effects monitoring from similar activities, and other sources of information are used to guide and inform the assessment and evaluation of environmental effects and the identification and proposal of mitigation.

In keeping with standard approaches and to optimize efficiency, the environmental effects assessment is therefore focused upon assessing and describing the likely residual environmental effects of the Project – namely, those which may occur following the implementation of the mitigation measures identified and proposed in the EIS.

The effects assessment for each VC is structured to consider and address each planned Project component or activity[2], as follows:

- Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)
- Drilling and Associated Marine Discharges (including fluids and cuttings)
- Vertical Seismic Profiling
- Well Testing
- Well Abandonment or Suspension
- Supply and Servicing

Where available and applicable, the effects assessment considers and utilizes relevant scientific, engineering, community, stakeholder, and Indigenous knowledge and perspectives, and includes the analysis of possible Project-related environmental interactions, changes and associated environmental

[2] These Project components are treated in individual yet integrated manner in the effects assessment, in that subsequent activities and their effects are not repeated and "double counted" in the analysis. For example, while VSP surveys and well abandonment or suspension activities may be undertaken from the MODU itself, the overall presence and operation of the MODU during these activities (and thus, its associated emissions and disturbances that are specific to that activity) are not repeated in the effects assessment for VSP.

effects to the VC that may result from these through one or more mechanisms or pathways. The assessment again also recognizes and considers the interactions and interrelationships between environmental components and systems and any predicted environmental effects.

The environmental effects assessments also utilize and incorporate existing information and knowledge about what is currently known and understood about the potential effects of offshore exploration drilling and associated activities on the VC in question. This includes relevant information and findings from the scientific literature, any reported environmental monitoring of other similar projects, and other sources where available, which are used to guide and inform the assessment and evaluation of environmental effects and the identification and proposal of mitigation.

The predicted (residual) environmental effects of the Project are described based on a number of standard and widely accepted environmental effects criteria or "descriptors", as listed and defined in Table 4.4.

Table 4.4 Environmental Effect Descriptors

Descriptor	Definition/Ratings
Nature / Direction of the Effect	Positive, Neutral or Negative (Adverse) (as compared to baseline environment)
Magnitude	The degree of change from baseline conditions in the affected area, as defined below. *For all VCs:* *Negligible*: Although there is potential for a Project-VC interaction, there would be no detectable effect *For the biophysical VCs:* *Low*: A detectable change that is within the range of natural variability, with no associated adverse effect on the viability of the affected population. *Medium*: A detectable change that is beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population. *High*: A detectable change that is beyond the range of natural variability, with an adverse effect on the viability of the affected population. *For the socioeconomic VCs* *Low*: A detectable change that is within the range of natural variability, with no associated adverse effect on the overall nature, intensity, quality, health or value of the affected component or activity. *Medium*: A detectable change that is beyond the range of natural variability, but with no associated adverse effect on the overall nature, intensity, quality, health or value of the affected component or activity.

Descriptor	Definition/Ratings
	High: A detectable change that is beyond the range of natural variability, with an adverse effect on the overall nature, intensity, quality, health or value of the affected component or activity.
Geographic Extent	The spatial area within which an environmental effect will likely occur *L:* Localized, In immediate vicinity of the activity *PA*: Within Project Area *LSA*: Within LSA *RSA*: Within RSA and/or beyond
Duration	The period of time over which an environmental effect will likely be evident *Short term*: For duration of the Project-related environmental disturbance that creates the effect *Medium term*: Beyond the duration of the Project-related environmental disturbance that creates the effect (recovery takes weeks or months) *Long term*: Beyond the duration of the Project-related environmental disturbance that creates the effect (recovery takes one or more years) *Permanent*: Recovery to baseline conditions unlikely
Frequency	How often an environmental effect will likely occur as a result of the Project activity in question: *N*: Not likely to occur *O:* Occurs once *S:* Occurs sporadically *R*: Occurs regularly *C*: Occurs continuously
Reversibility	The ability of an environmental component to return to an equal or improved condition once the disturbance(s) that caused it has ended: *Reversible*: Will eventually recover to baseline conditions *Irreversible*: Permanent

Descriptor	Definition/Ratings
Certainty	The level of confidence in the effects prediction: *L*: Low level of confidence *M*: Moderate level of confidence *H*: High level of confidence

Although not a specific effects "rating" per se, the current condition of an environmental component as a result of natural and/or anthropogenic factors, and thus, its resulting resiliency or sensitivity to further change (ecological/socioeconomic context) is considered integrally as part of the prediction of environmental effects, and is summarized in the effects summary tables provided for each VC.

The level of confidence in each environmental effects prediction is indicated throughout, along with an associated discussion of key sources of uncertainty, data gaps, issues of reliability, sensitivity, and approaches to conservativeness in effects prediction and the identification of mitigation. Assumptions are also defined and discussed and justified where relevant.

For the biological VCs (marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles), associated Species at Risk are addressed in a fully integrated manner within the larger VCs themselves. Each VC chapter provides a summary discussion of the various relevant Species at Risk, including an overview of those that have the potential to interact with the Project, and a species by species summary of the Project's potential for effects on these species and associated mitigation.

The environmental effects assessment for each VC concludes with a summary of the predicted residual environmental effects of the Project's planned components and activities, and evaluates the significance of these based on the VC-specific significance definitions developed and presented at the beginning of each VC chapter. Any key sources of uncertainty or assumptions made in defining and determining environmental effects significance are also presented and justified where relevant. If significant effects are predicted, the likelihood of their occurrence is discussed.

4.3.4 Environmental Monitoring and Follow-up

Each VC section also identifies and describes any proposed environmental monitoring and/or follow-up activities which may be required or appropriate in relation to the Project. For the purposes of this EIS, these are defined as follows:

> *Monitoring programs* are those that are implemented to meet standard regulatory requirements (such as may be required as a result of eventual Project authorizations), to demonstrate compliance to other environmental obligations or commitments, or as part of corporate systems and applicable operational practices.
>
> *Follow-up programs* are those that may be required and implemented to address any EA-related issues of uncertainty, such as to verify the environmental effects predictions and/or the effectiveness of implemented mitigation measures.

Each VC chapter includes an overview discussion of any such environmental monitoring and/or follow-up programs that may be required or proposed for the VC. This includes, where applicable, a preliminary overview of its: rationale and objectives; planning and design; key areas of focus; implementation and schedule; the format, use and sharing of study results; and potential adaptive management approaches based on the results and findings of any such programs.

4.4 Cumulative Environmental Effects

As required under Section 19(1) of CEAA 2012, the EIS assesses and evaluates any cumulative environmental effects that are likely to result from the Project in combination with other physical activities that have been or will be carried out, as well as the significance of these potential effects. The cumulative effects assessments for all VCs are reported together in Chapter 15.

Additional information on the approach and methods used for the completing the cumulative effects assessment is provided in Section 15.1.

4.5 Accidental Events

In addition to considering planned Project components and activities, the EIS also assesses and evaluates the potential environmental effects that may be associated with unplanned events such as an accident or malfunction during any phase of the Project.

Chapter 16 (Accidental Events) describes and assesses possible accidental events and malfunctions that could occur as a result of the Project, including the results of associated modelling conducted for the Project and this EIS. It also describes relevant accident prevention and emergency response plans and procedures, and assesses and evaluates the potential effects of these possible accidental events for each VC. This includes providing information and analysis related to:

- Nexen's plans, systems and procedures related to oil spill prevention and response
- The various types of accidental events that may be associated with the Project and associated scenarios, and
- Spill risk and probabilities, and the predicted fate and behavior of potential spills (summarizing and incorporating the results of the associated spill modelling conducted for the Project and its EIS, see Appendices F to H)

The potential effects of these possible accidental events are assessed and evaluated for each VC in a separate subsection, using the same overall approaches and descriptors as those described above for planned Project activities. The assessment also includes a determination of the significance of such effects, again based on the same significance definitions developed and described in Section 4.3.

Additional details on the approach and methods used in the environmental effects assessment for accidental events is provided in Section 16. 6.

4.6 Effects of the Environment on the Project

As required by the EIS Guidelines (Section 6.6.2), the EIS provides an assessment of the potential "effects of the environment on the Project", as reported in Chapter 17. This includes consideration of the manner in which local conditions and natural hazards (such as severe or extreme weather conditions and other external events) could affect Project planning and/or implementation, and how this in turn could result in effects to the environment. This analysis also includes an associated discussion of how these or other environmental conditions and factors have or will influence the design and execution of the Project (such as ice conditions, weather, geology), as well as associated planning, design and operational measures that will be taken to help protect the environment.

4.7 References

CEAA (Canadian Environmental Assessment Agency) (2015). Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under CEAA 2012. Ottawa, Ontario. Catalogue Number: En106-145/2015E-PDF

5 EXISTING PHYSICAL ENVIRONMENT

The following sections provide a descriptive overview of relevant components of the existing (baseline) physical environment of the Project Area and surrounding areas, including aspects of its geology, bathymetry, climatology, oceanography and ice conditions. Although the various physical components and processes that are described in this Chapter are not Valued Components (VCs) for the purposes of the environmental effects assessment (Chapters 8-16), information is provided as background and context for the EIS, and in accordance with the requirements and specifications of the EIS Guidelines. Some of these environmental features and processes are also relevant to understanding and assessing the potential environmental disturbances, and associated environmental changes and effects pathways, that may lead to potential effects on one or more of the VCs under consideration.

The most direct relevance of this information for this EA is in assessing and evaluating the potential "effects of the environment on the Project" (see Chapter 17), including the manner in which physical environmental conditions have and may eventually affect the planning and conduct of in-field Project activities. As such, the focus of this section is on the Project Area itself as well as the associated vessel and aircraft traffic routes. In some cases physical environmental conditions and processes are also relevant to the presence, distribution and other aspects of components of the biophysical and socioeconomic VCs and potential project-related environmental changes and effects upon them. These are also described and considered on a regional scale as part of the descriptions of the existing biological and socioeconomic environments (Chapters 6 and 7) as relevant, and in the VC-specific environmental effects assessments (Chapters 8 to 16)[3].

5.1 Geology and Geomorphology

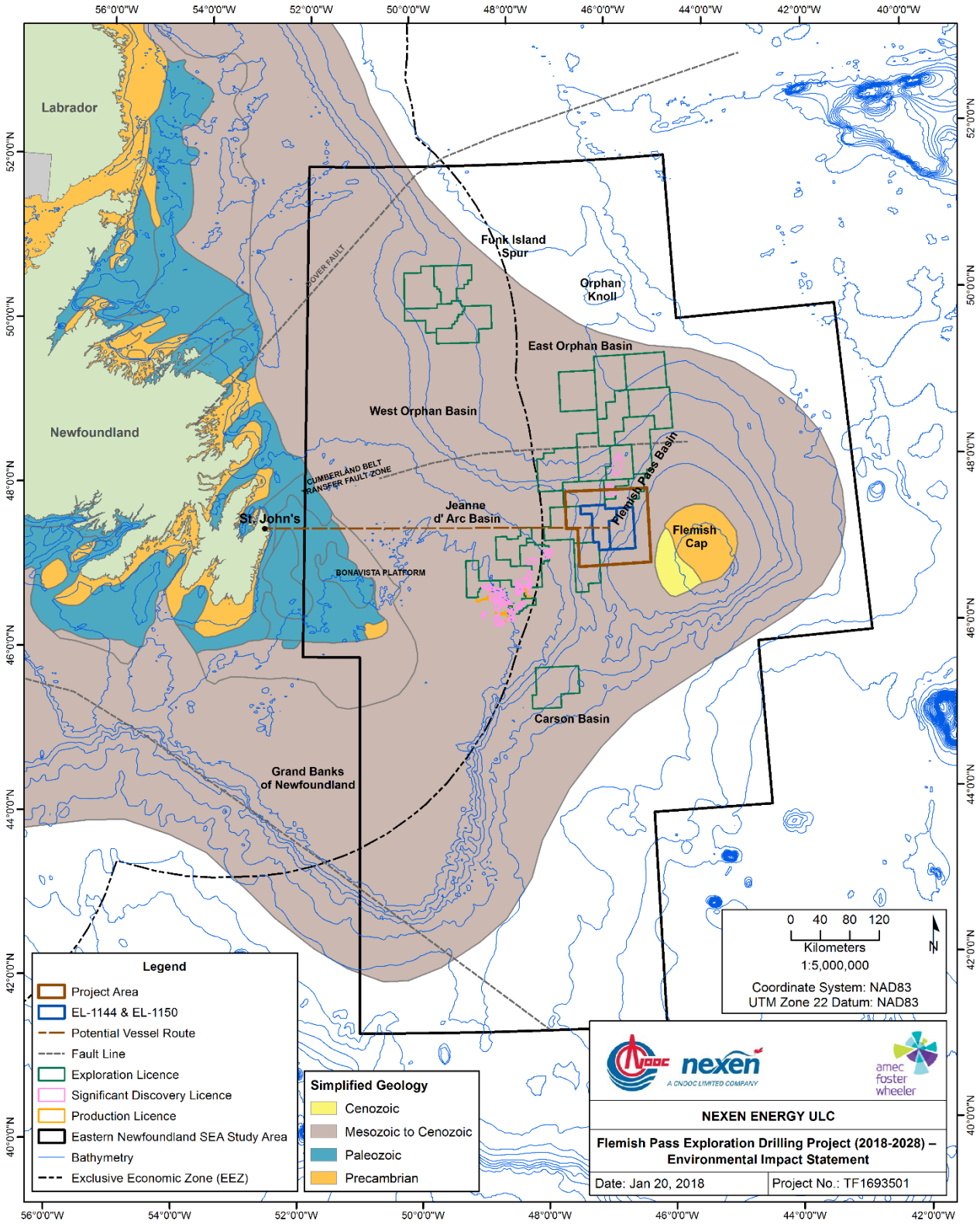
The geology of the Eastern Newfoundland offshore area is complex and dynamic, and the current bedrock and surficial characteristics of the region have been shaped by various factors and processes over time.

5.1.1 Bedrock Geology

The Project Area is located on the eastern continental shelf of the offshore region of the Newfoundland continental margin and is comprised of Tertiary and Mesozoic rock overlying pre-rift, Appalachian basement rock of the Avalon terrane (Fader et al 1989, Figure 5.1). The area was formed by a series of three rift episodes associated with the breakup of the supercontinent Pangea and the opening of the North Atlantic Ocean during the Late Triassic to Tertiary. These rifting events, combined with salt tectonics in the area, created a complex series of Mesozoic rift basins that are generally oriented northeast - southwest and are separated by basement highs along the central to outer shelf. The resulting combination of stratigraphy, structure and timing have been conducive to hydrocarbon generation and entrapment (Bell and Campbell 1990).

[3] Most of the figures included in this and subsequent chapters of the EIS use a somewhat simplified version of the EIS base map to optimize the presentation of the information included therein. For further details on existing oil and gas related licences, bathymetry and other features, please refer to Figure 1.1 and others in the preceding Chapters.

Figure 5.1 Geological Overview (Bedrock)



Source: Fader et al (1989); Enachescu and Fagan (2005)

The Flemish Pass is the main sedimentary basin in the Project Area as shown in Figure 5.1. The Flemish Pass is a north-east – south-west trending, mid-slope basin located between the Grand Banks and the Flemish Cap. The primary reservoirs are shallow marine and fluvial sandstones deposited during the Late Jurassic and Early Cretaceous periods of the Mesozoic Era. The Late Jurassic Egret member of the Rankin Formation is a world-class source rock that is recognized as the primary source of the oil and gas discovered in the Jeanne d'Arc Basin and has also been proven to be widespread in the Flemish Pass Basin (G and G 2003). The chronostratigraphy of the area is illustrated in Figure 5.2.

5.1.2 Geomorphology and Surficial Geology

The geomorphology and surficial geology in and around the Project Area is a product of modern oceanographic processes and past glacial activity, a generalized overview of which is provided in Figures 5.3 and 5.4.

Some notable geomorphic features in the region include the Sackville Spur and the Flemish Cap. The Sackville Spur is a prominent contourite drift which formed during the Neogene-Quaternary located at the northern end of the Flemish Pass (Marshall et al 2014) and has been incised by numerous canyons. The Flemish Cap is a large, isolated continental basement high which is separated from the Grand Banks by the Flemish Pass and represents the most easterly extension of North American continental crust (King and Fader 1985). It is underlain by Avalon terrane bedrock and consists of a central core of Hadrynian rocks, including granodiorites, granites, dacites and an onlapping sequence of Mesozoic to Cenozoic aged sediments (King et al 1986). Locally, it is covered by a veneer of sand up to several metres thick (Weitzman et al 2014). Seabed features include iceberg scouring in the north-west and south-east portions of the Project Area (Cameron and Best 1985).

The surficial geology of the region is highly variable, but generally in water depths less than 600 m the shallow geology consists of glacial till with a veneer of sand and gravel up to several metres thick. In deeper water, the seabed generally consists of Holocene silty mud. On parts of the floor of the Flemish Pass, winnowed sands are present (Murillo et al 2016). The coarser-grained sediments are found through the center and western side of the Flemish Pass while the finer-grained sediments are concentrated predominately on the eastern side of the Pass, including the terrace (Marshall et al 2014). According to Piper and Campbell (2005), the western slopes of the Flemish Pass are comprised mainly of muds with some coarse-grained ice-rafted detritus. Interbedded sandy turbidites are most abundant between 2 and 3.5 metres below sea floor. On the floor of the central part of the Flemish Pass, successions of silty muds with ice-rafted detritus, thin sand, and mud turbidites overlie thick bedded sand turbidites. On the eastern slopes of the Flemish Pass, sediment consists primarily of mud with sparse ice-rafted detritus.

Figure 5.2 Chronostratigraphy of Jeanne d'Arc Basin, Central Ridge and Flemish Pass Basin

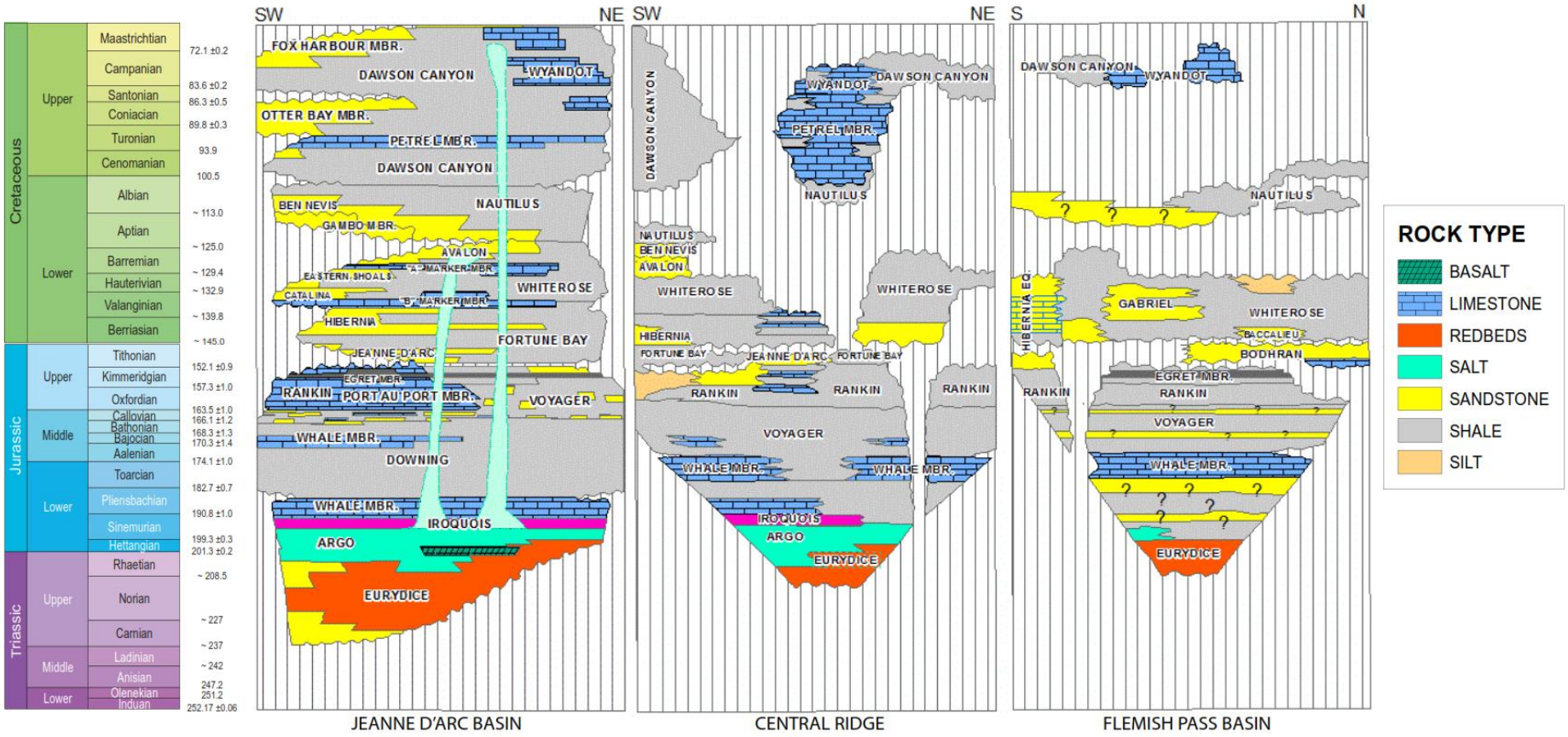
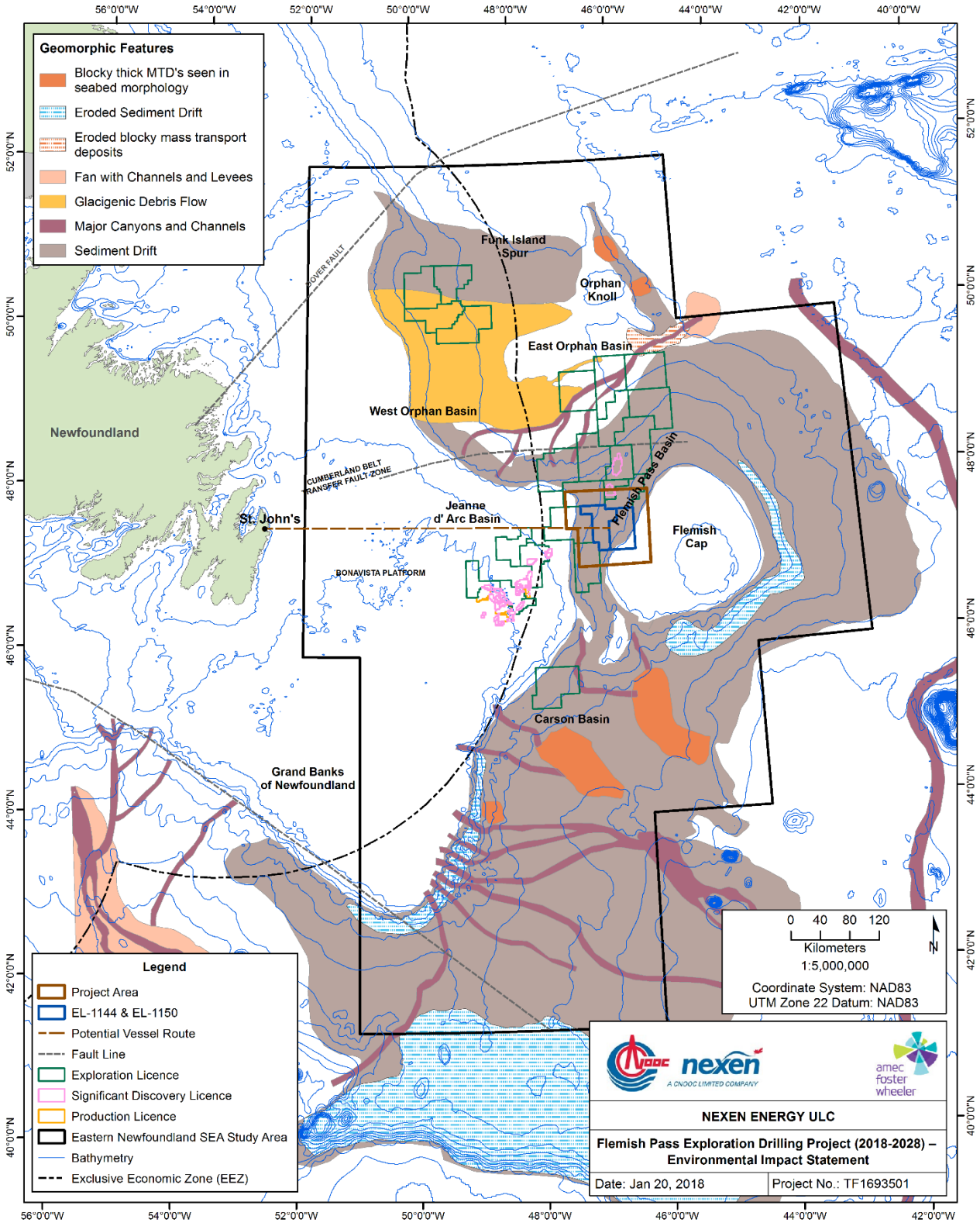
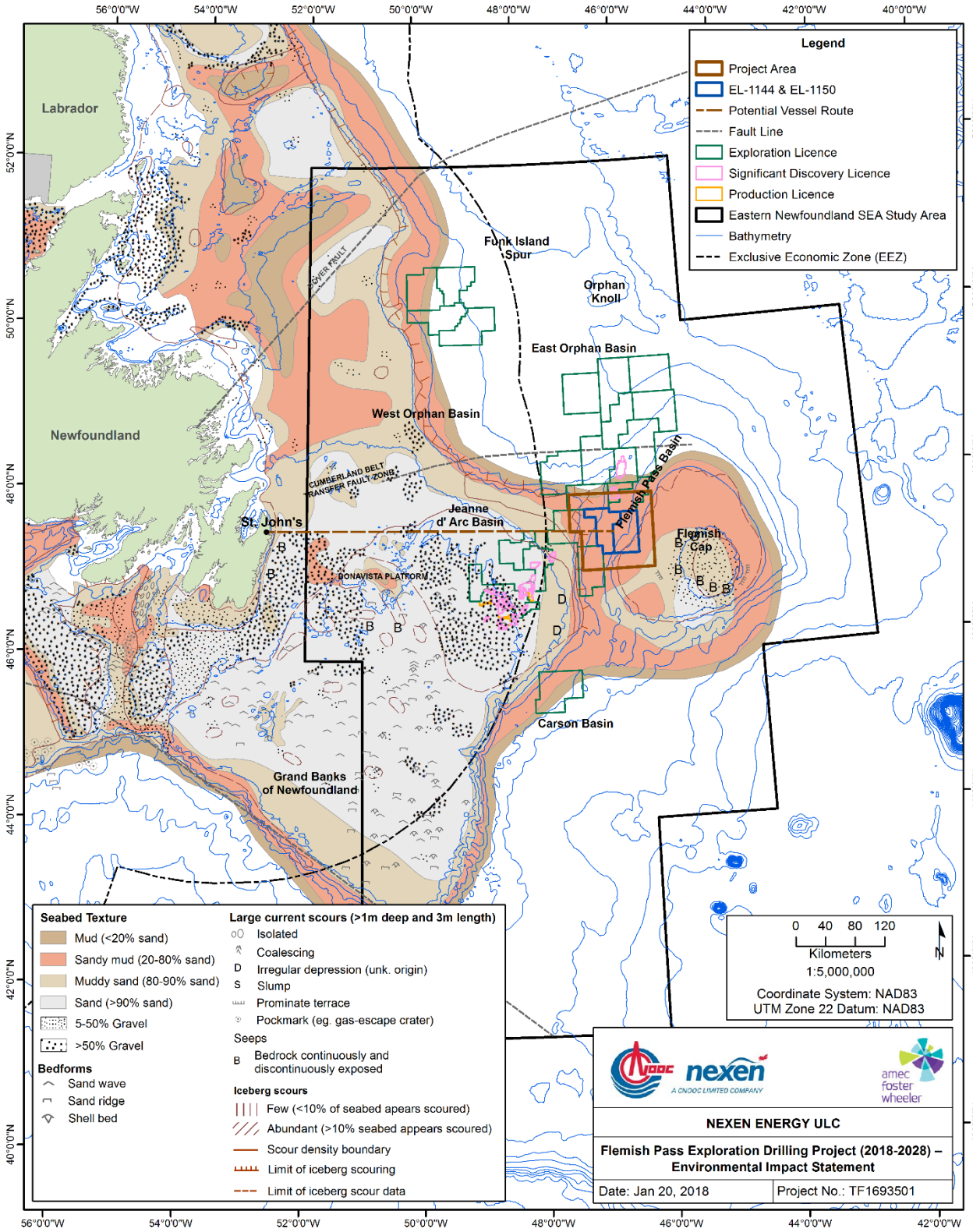


Figure 5.3 Geomorphic Features



Source: Rudolph et al (2017)

Figure 5.4 Seabed Features



Source: Cameron and Best (1985)

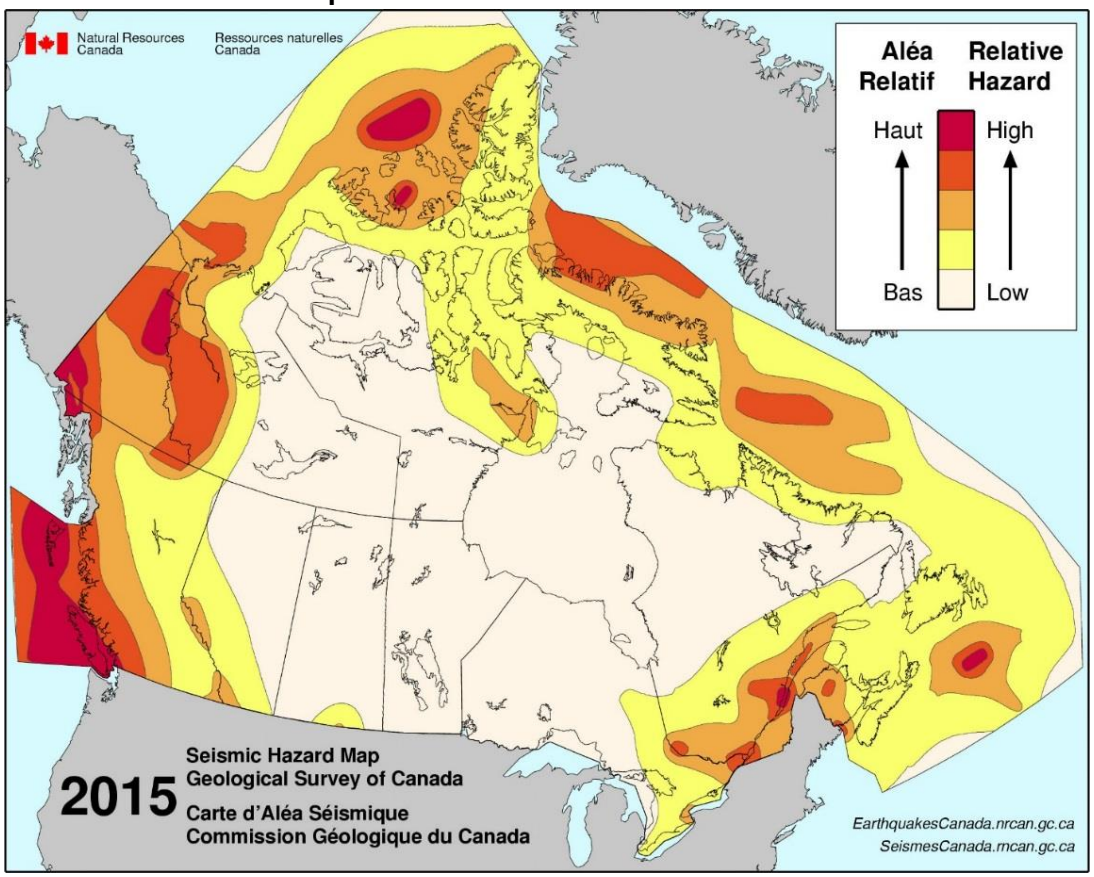
5.1.3 Geohazards

Common offshore geohazards may include seismicity, slope instability, venting of shallow gas, gas hydrates, and faulting. The discussion that follows is, based on the existing information sources used, necessarily regional in scope, although any known features and processes that are specific to parts of the Project Area are highlighted where relevant. In addition, as discussed in Chapter 2, geohazard data will be collected in the area of each well prior to drilling, in accordance with relevant regulatory requirements.

5.1.3.1 Seismicity

Canada's eastern continental margin is tectonically passive and seismicity is relatively rare throughout much of the region. Natural Resources Canada (NRCan) estimates that approximately 450 earthquakes occur each year in Eastern Canada (NRCan 2017a). Seismicity is generally concentrated south of the Grand Banks margin. The most recent edition of the Seismic Hazard Map prepared by NRCan (Figure 5.5), which illustrates the probability of earthquake occurrences across Canada, indicates that the Project Area and surrounding areas have been classified as having a relatively low seismic hazard.

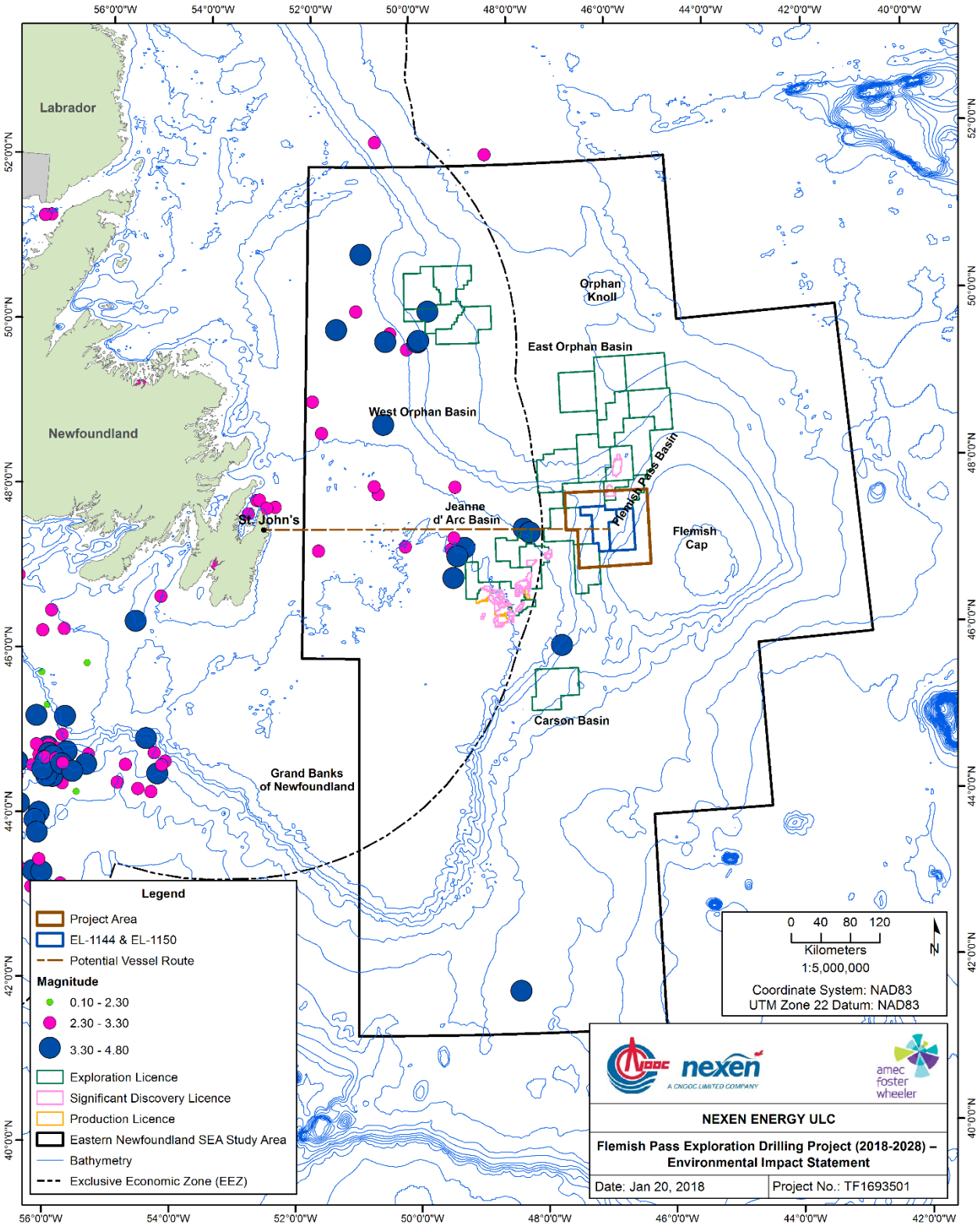
Figure 5.5 Seismic Hazard Map



Source: NRCan (2017b)

According to the National Earthquake Database (NRCan 2017c) there have been no seismic events recorded within the boundaries of the Project Area within the 1985-2017 period (Figure 5.6). The closest recorded event is over 50 km from the edge of the Project Area.

Figure 5.6 Earthquake Epicentres (1985-2017) and Seismotechtonic Setting



5.1.3.2 Slope Instability and Faulting

Sediment failure is essentially a consequence of gradient, magnitude of seismic acceleration and sediment strength. Most continental margin sediments, except on slopes of more than a few degrees, are relatively stable and would require seismic accelerations associated with a large earthquake (magnitude of five or greater) to fail (Nadim et al 2005).

NRCan analysis indicates that in any given area offshore Eastern Canada, there is a risk of a major landslide every 20,000 years and a minor one may occur every few thousand years. Most of the large failures on the seabed date back more than 10,000 years during periods of glaciations when large amounts of sediment were deposited directly onto the slope of the continental shelf (NRCan 2010). Synchronous failures in multiple drainage systems suggests that most failures are earthquake triggered, with some seismicity induced by glacio-isostasy (Piper 2005). The mean recurrence interval of earthquakes with magnitudes of seven at any point on the margin is estimated at 30,000 years from seismological models and 40,000 years from the sediment failure record (Piper et al 2011).

Piper and Campbell (2005) present a regional geohazard assessment of the Flemish Pass area that suggests that most large debris flow deposits in the area are the result of earthquake triggered slumps on both flanks of the Flemish Pass. Geotechnical studies from piston cores show that these failed sediments are silty and have potential for liquefaction during cyclic loading (Piper 2014).

The risk of natural large slope failure in the Flemish Pass appears very low with a recurrence interval of 100,000 years. It is likely preconditioned by high pore pressure and triggered by earthquakes. Generally, in the northern Flemish Pass, the steep slopes, abundant shallow gas, and possibly greater seismicity (D. Piper, pers comm) make large landslides somewhat more frequent, with a recurrence interval of 10,000 years as a worst-case scenario. This translates to a 1 in 500 risk of a landslide occurring within an approximately 20 year period (Cameron et al 2014).

Faults may allow migration of basinal fluids upwards, leading to excess pore pressure. Leakage of basinal fluids may precondition the seabed to be more likely to fail in earthquake-triggered landslides. Faulting can also lead to problems during drilling such as loss of circulation.

5.1.3.3 Shallow Gas and Gas Hydrates

Evidence for shallow gas is widespread in Flemish Pass (Cameron et al 2014). Shallow gas can lead to excess pore pressure in permeable strata such as silts and can be linked to submarine landsliding. Piper and Campbell (2005) indicate that gas hydrates may also act as a trigger for slope failure in the Flemish Pass as observed by a pattern of younger debris-flow deposits in the central region of the area. Bottom water temperature in Flemish Pass is buffered by the supply of cold arctic water through the Labrador Current, so that times of gas hydrate melting are likely restricted to periods of falling sea level between interglacial and glacial maximum conditions. Falling sea level results in less hydrostatic pressure in seabed sediments and consequently a melting of gas hydrate.

5.1.3.4 Tsunamis

Tsunami hazard along the Atlantic coast of Canada is relatively low, with very few tsunamis recorded. There are no active plate boundaries nearby to generate tsunamis by displacement of the seafloor, but

submarine landslides triggered by earthquakes can produce a tsunami. In a preliminary tsunami hazard assessment of the Canadian coastline, Leonard et al (2010) use a tsunami runup threshold of 1.5 m for potentially damaging coastal waves and a tsunami runup threshold of 3.0 m for significant damage potential. Their assessment of the outer Atlantic coastline indicates an expected recurrence of runup exceeding 1.5 m approximately every 300 to 1,700 years. For larger runup (over 3.0 m), the estimated recurrence interval is approximately 600 to 4,000 years. Leonard et al (2010) assume that a mean local runup greater than 1.5 m could result from failures with an along-slope extent over 50 km, and a mean local runup of greater than 3.0 m may be produced from failuresover 70 km in length. In the Orphan Basin, the expected recurrence interval of landslides with an extent of over 50 km is approximately 10 thousand years. In Flemish Pass, such threshold landslides are expected to occur with an average recurrence interval of approximately 21 thousand years. Continental slope failures with extents greater than 70 km are expected approximately every 11.5 thousand years in Orphan Basin and approximately every 45 thousand years in the Flemish Pass.

5.2 Bathymetry

The bathymetry of the Project Area and its surrounding regions is generally well known. The Project Area itself is about 100 km x 100 km in size, with its western boundary located over 400 km from the Island of Newfoundland. The Project Area is generally centred over the deep Flemish Pass which separates the Grand Banks on the west and the Flemish Cap to the east. Depths on the Grand Banks as a whole generally range between about 75 and 200 m and slope down to about 400 to 500 m in the northwest corner of the Project Area towards the Sackville Spur. The deepest parts of the Flemish Pass are almost 1,300 m. To the southeast, the seabed steeply slopes back up from the Flemish Pass to depths of 300 m on the western side of the Flemish Cap, a large bathymetric feature of about 50,000 km^2 with depths rising back up to about 130 m. The southwestern portion of the Project Area lies over the steep eastern edge of the Grand Banks at depths of about 1,100 m, while to the northeast of the Project Area the seabed is similarly steep and reaches 600 m on the slopes of the Flemish Cap.

On a more regional scale, to the north of the Project Area lies the Sackville Spur which extends the nose of the Grand Banks to the northeast at depths of up to 1,000 m. North of the Sackville Spur lies the Orphan Basin, with water depths ranging from about 1,200 m at the edge of the continental shelf to as deep as 3,500 m. Much farther to the north, in water depths of around 2,000 m, lies the Orphan Knoll, a bathymetric high in the centre of the Orphan Basin. The Labrador Basin and deep ocean lie farther offshore to the north and east of the Orphan Basin and Flemish Cap, with depths from approximately 3,000 m to greater than 4,000 m.

Some of the key bathymetry features are shown in Figure 5.7 and Figure 5.8 (the latter being focused on the Project Area itself). The potential vessel and aircraft traffic route to the Project Area crosses the Avalon Channel immediately east of St. John’s, the northern portion of the Grand Banks, the nose of the Grand Banks and the western boundary of the Project Area. Farther east the route continues across the Flemish Pass and western slopes of the Flemish Cap. Over this route depths range from about 160 m east of St. John’s, to about 100 m over most of the Grand Banks, reaching 200 to 300 m and deeper into the Flemish Pass.

Figure 5.7 General Bathymetry and Ocean Current Circulation, Regional View

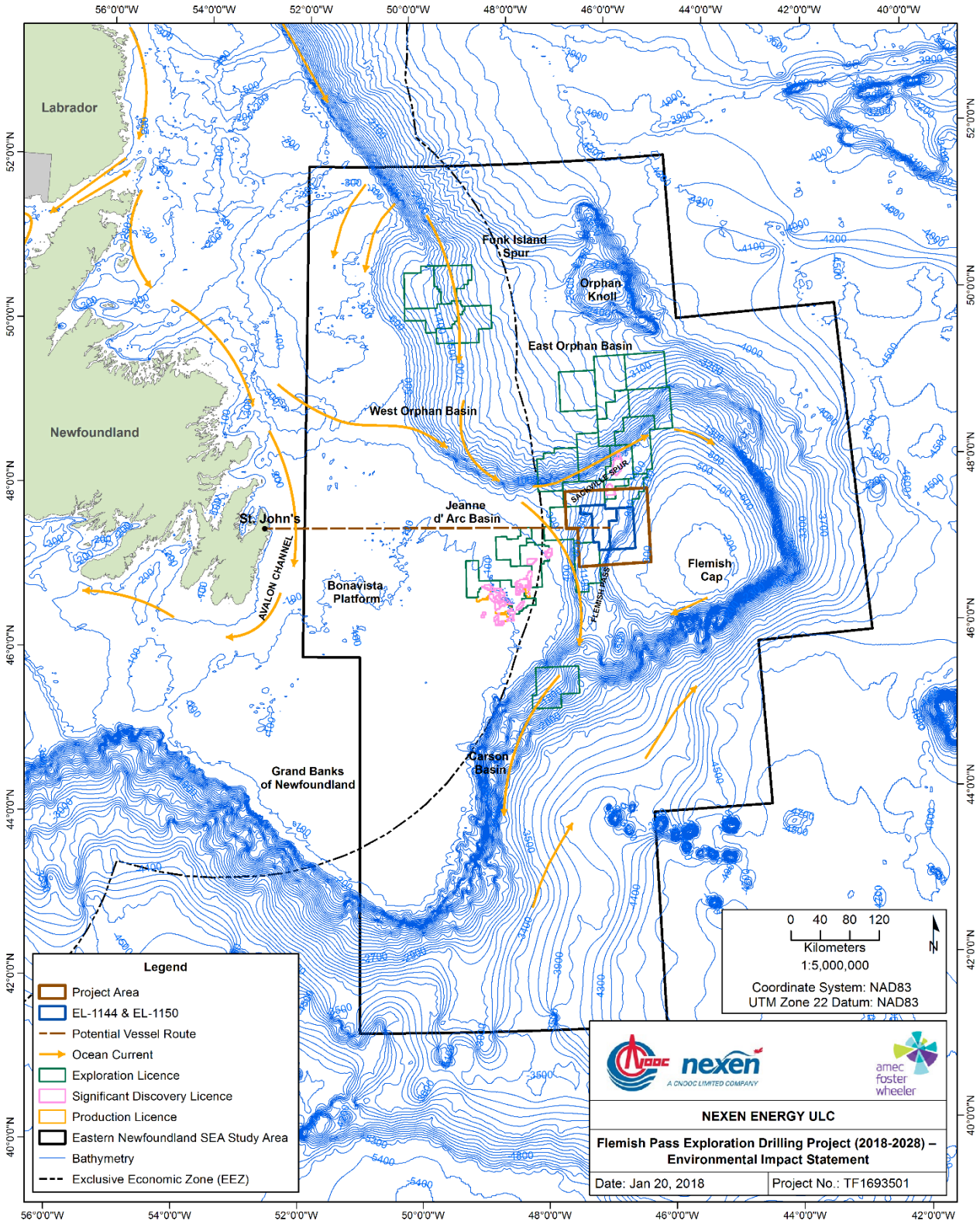
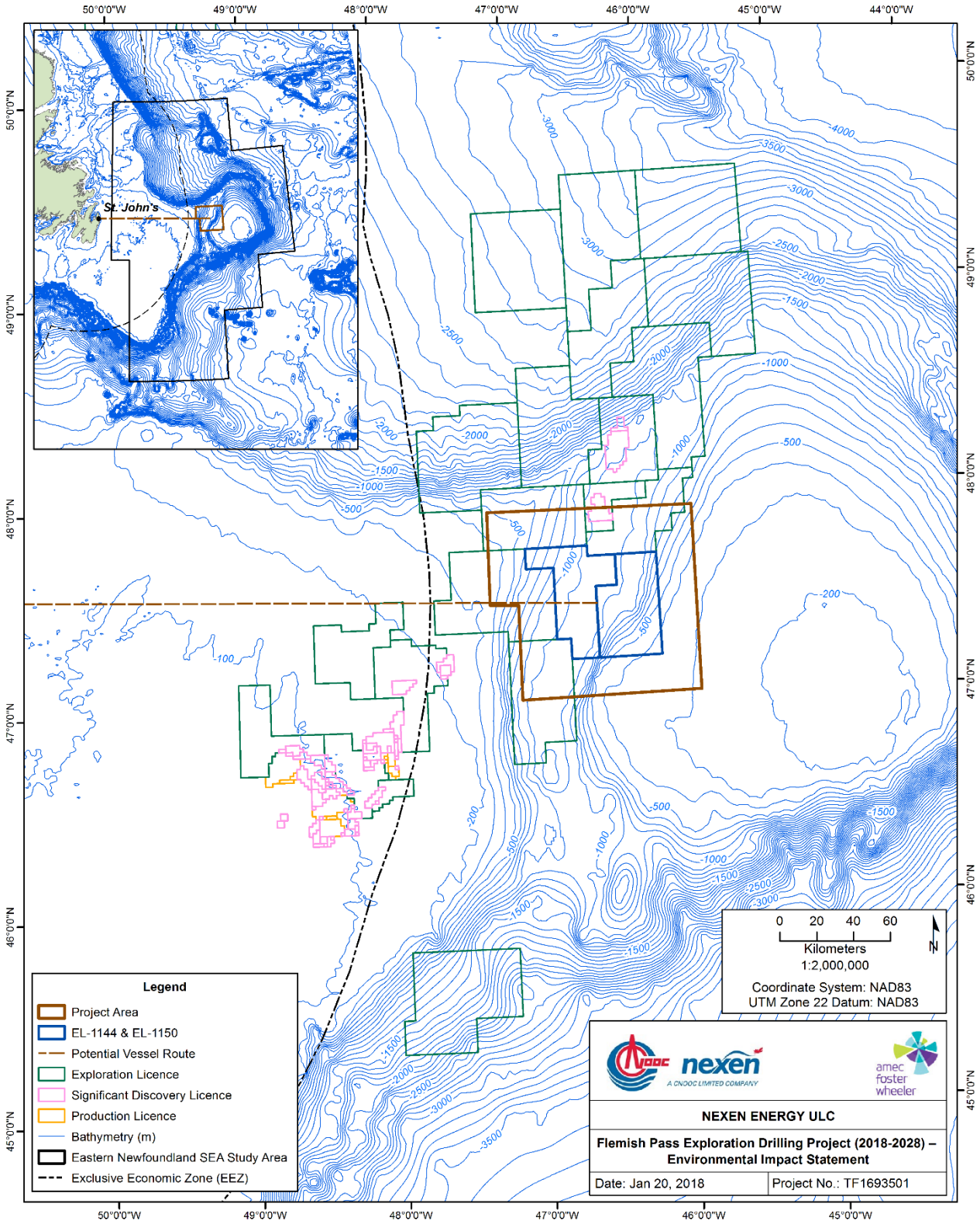


Figure 5.8 General Bathymetry, Project Area



5.3 Climatology

This section provides an overview of key climatological conditions and characteristics of the Project Area, including wind, air temperature, precipitation, fog and visibility. Additional detail on these environmental characteristics of the Project Area and the larger Eastern Newfoundland Offshore Area is provided in the Eastern Newfoundland SEA, Section 4.1 (Amec 2014).

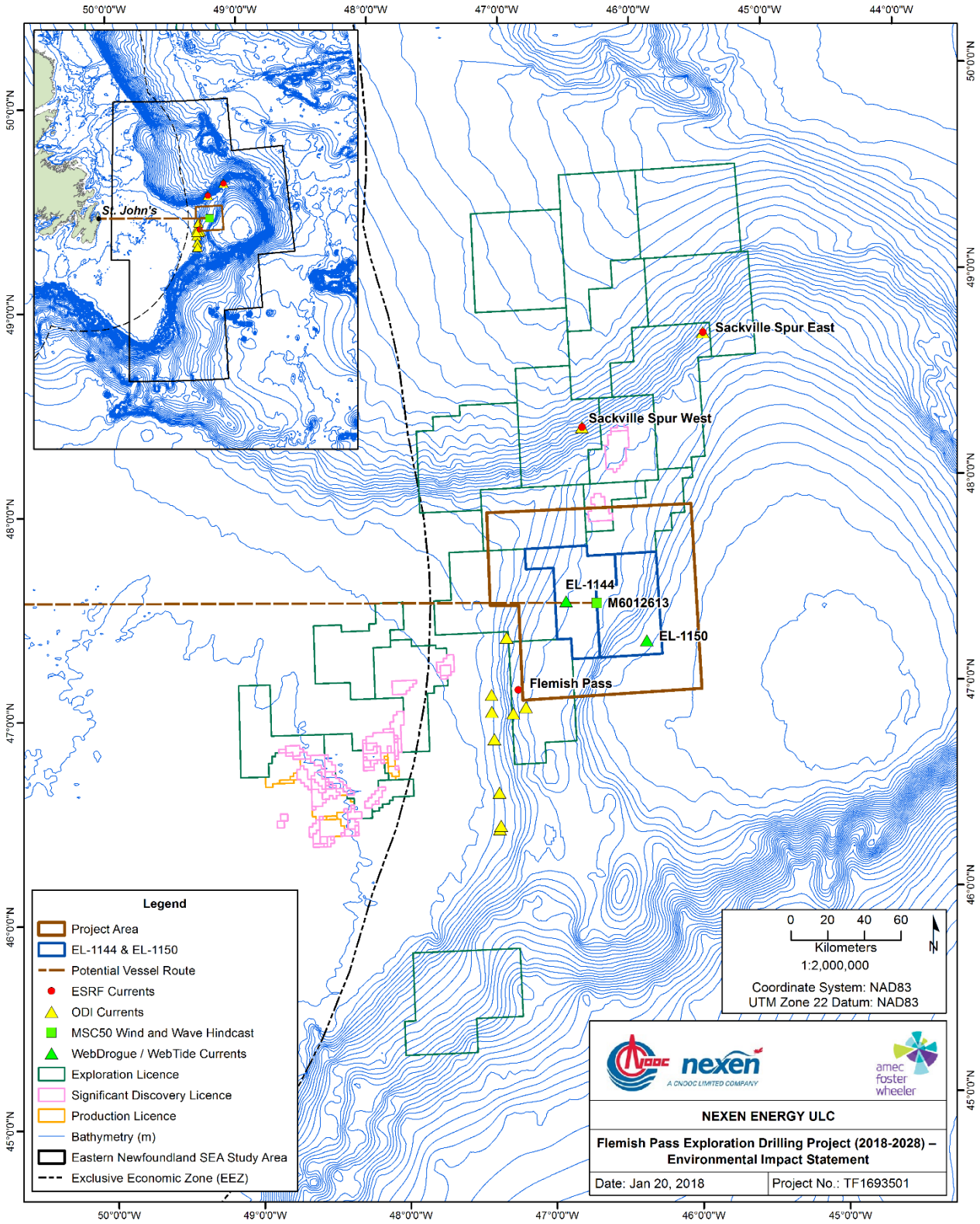
5.3.1 Wind Speed and Direction

The wind climatology of the Project Area is characterized using statistics derived from the MSC50 wind and wave hindcast dataset. The MSC50 dataset includes hourly wind and wave parameters of the North Atlantic Ocean and includes consideration of iced-over periods (Swail et al 2006). The hindcast data were produced through the kinematic reanalysis of all significant tropical and extra-tropical storms in the North Atlantic. The dataset covers hourly wind and wave parameters, from 1954 to 2015, for the North Atlantic Ocean and includes consideration of periods with sea ice coverage. Ice concentration data considered is a mean monthly value through 1961 inclusive and then Canadian Ice Service (CIS) mean weekly ice concentration for 1962 onwards. That is, ice is applied for an entire calendar week, e.g., one would see something like the 1st to 7th of the month is ice, then 8th to 14th isn't, etc. Subsequently, given the poorer resolution of ice information, the 1954-1961 period of the MSC50 dataset was excluded from the present analysis; the 1962-2015 periods are considered for wave and, for consistency, wind.

The overall resolution of MSC50 hindcast data grid points (nodes) in this area is high, with one point every 0.1° latitude by 0.1° longitude (about 7.6 km east-west and 11.2 km north-south near 47°N). To provide a characterization of wind and wave conditions, a grid point location in the middle of the Project Area (M6012613 at 47.5°N, 46.5°W and water depth of 1,148 m), was selected, and is shown in Figure 5.9.

The MSC50 wind speeds are 1-hour average wind speeds at a height of 10 m above sea level. Wind speed measurements are frequently averaged over shorter durations (e.g., 10 minutes for marine reports and two minutes for aviation, and a one minute average is used for the categorization of tropical cyclones). Wind gusts are typically for one, two or five second durations. Several formulas (e.g., ISO/DIS 19901-1 (2005)), can be used to scale winds to averaging times less than 1 hour and for different reference elevations (e.g., between 10 meters and MODU anemometer height or vice versa), and are frequently applied in design criteria studies applying measured and hindcast data sets.

Figure 5.9 Locations of the Wind and Wave MSC50 Node and Ocean Currents



Wind conditions for the Project Area (for MSC50 Node M6012613, near the centre of the Project Area) are summarized with monthly and annual statistics presented in Table 5.1 together with monthly and annual wave roses in Figures 5.10 to 5.11.

Table 5.1 Wind Statistics, MSC50 Node M6012613 (1962 – 2015)

Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Wind Speed (m/s)	11.7	11.5	10.2	8.5	7.3	6.8	6.2	6.6	7.8	9.3	10.0	11.1	8.9
Most Frequent Direction (from)	W	W	W	W	SW	SW	SW	SW	W	W	W	W	W
Maximum Speed (m/s)	34.3	30.9	28.9	26.8	24.8	23.2	19.7	26.7	27.2	27.2	27.1	29.7	34.3
Direction of Max Wind Speed (from)	W	S	W	N	NW	W	S	S	SE	NW	NW	NW	W

Mean hourly wind speeds for the Project Area range from about 6.2 m/s in July to 11.7 m/s in January, while the strongest winds of 34.3 m/s occur in January. The maximum wind speeds indicate that gale force winds, in the range from 17.5 to 24.2 m/s (47 knots or 87 km/h), occur in June and July, while storm force winds, in the range from 24.7 to 32.4 m/s, can occur during the rest of the year. The monthly and annual directional distributions of the winds are shown in Figure 5.10 and Figure 5.11.

The range of wind conditions experienced along the potential vessel and aircraft travel route from Eastern Newfoundland to the Project Area are likely to be quite close to those experienced farther offshore. During the fall and winter periods, monthly average wind speeds farther offshore can be expected to be 1 to 2 m/s higher than those near St. John's, whereas maximum wind speeds can be expected to be at least 2 to 3 m/s higher. Further information on the regional wind environment in this area is provided in the Eastern Newfoundland SEA (Amec 2014), Section 4.1.3.

Figure 5.10 Monthly Wind Roses, MSC50 Node M6012613 (1962–2015)

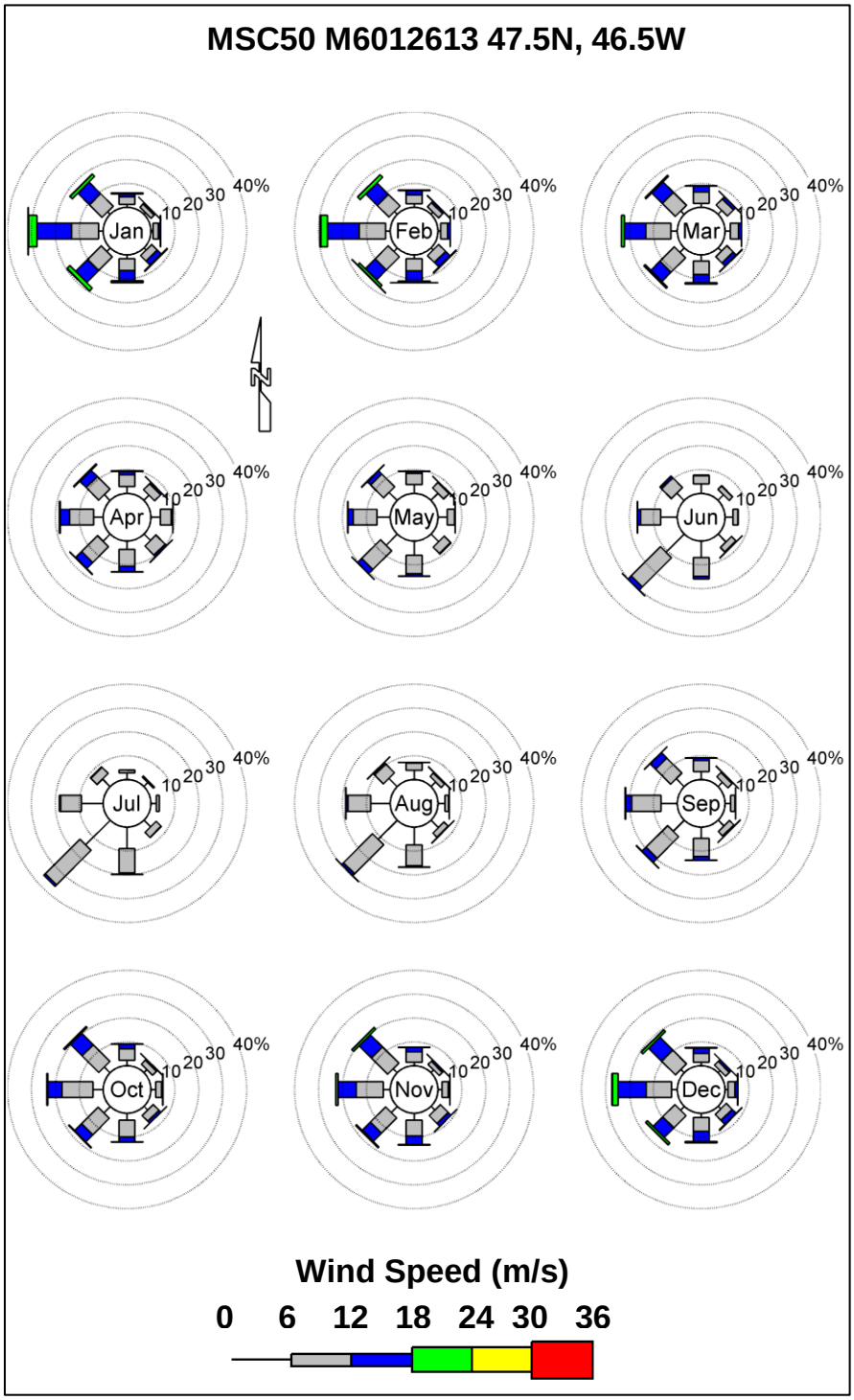
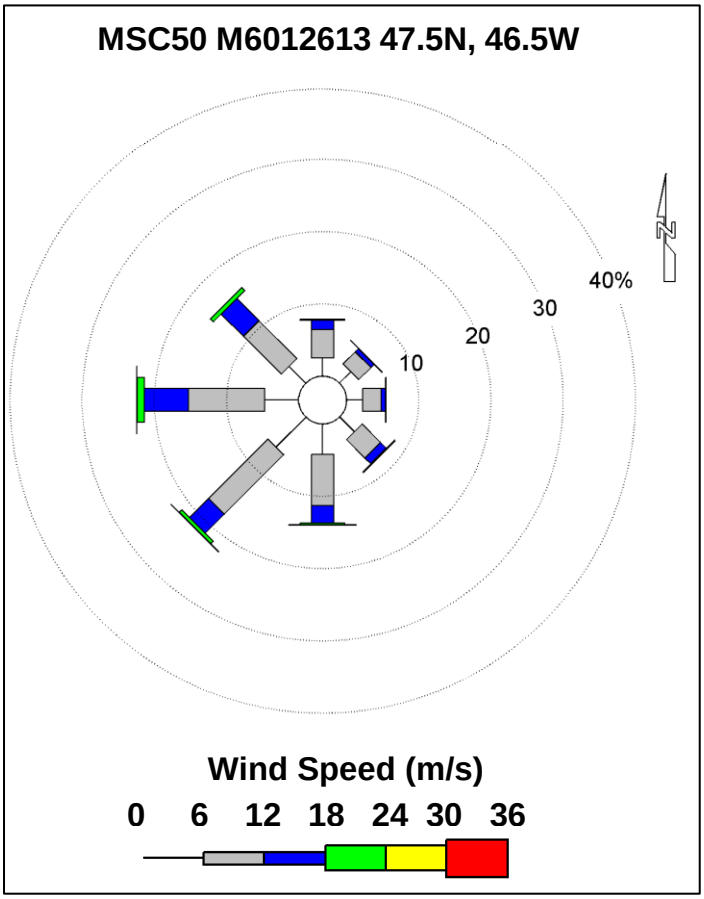


Figure 5.11 Annual Wind Rose, MSC50 Node M6012613 (1962–2015)



5.3.2 Air Temperature

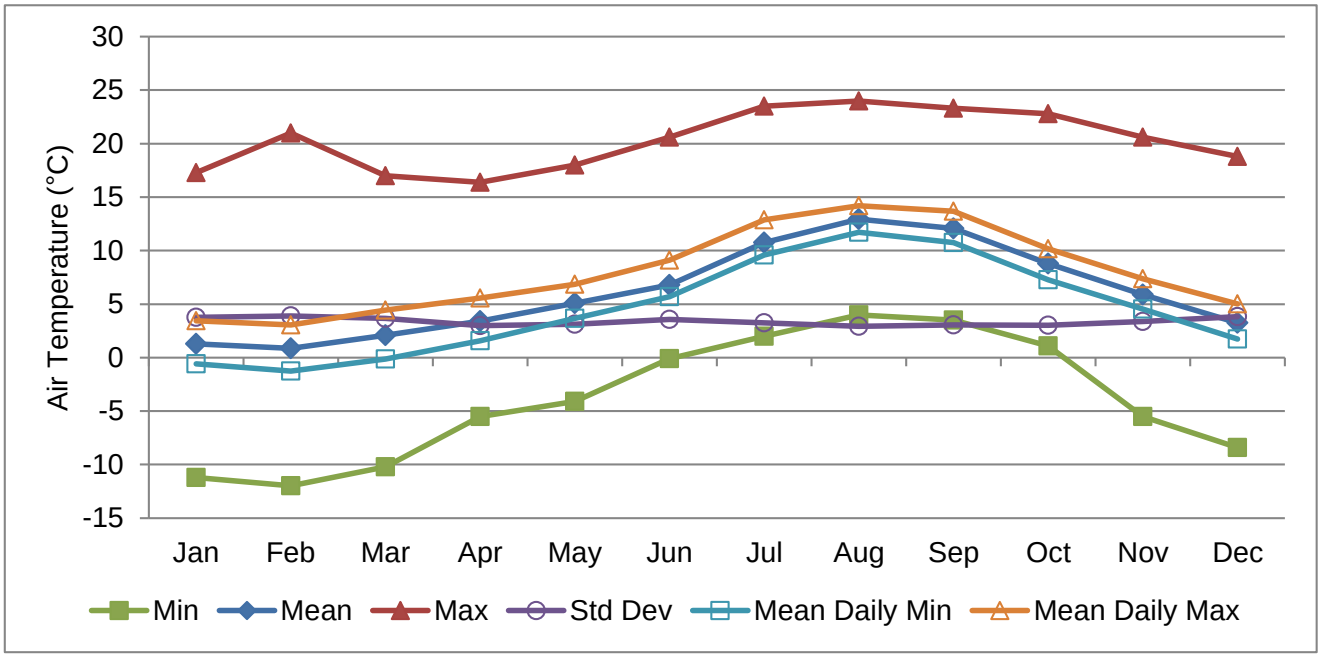
Atmospheric properties over the ocean surface, including air temperature, precipitation and visibility have been characterized using the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). ICOADS represents the most extensive available database of observations of atmospheric and sea conditions. The dataset consists of global marine observations recorded from 1662 to the present, compiled by the United States National Centre for Atmospheric Research (NCAR 2012). Conditions for the Project Area have been characterized by selecting all ICOADS observations within the Project Area for the period January 1960 to December 2016, inclusive.

Monthly air temperature statistics for the Project Area are presented in Table 5.2 and Figure 5.12. Air temperature exhibits strong seasonal variations, with mean temperatures ranging from 0.9°C in February to 12.9°C in August. The coldest observed air temperature on record (-12.0°C) was in February, while during the summer months the coldest observed temperatures ranged from -0.1°C in June, and 2.0°C in July. The highest observed temperatures during winter months are approximately 19°C, while in summer the values reach as high as 24.0°C. Throughout the year the mean daily minimum and maximum temperatures generally stay within about 3°C of the mean temperature.

Table 5.2 Monthly Air Temperature (°C) Statistics

Month *	Mean	Max	Min	SD	Mean Daily Min	Mean Daily Max
Jan	1.3	17.3	-11.2	3.8	-0.6	3.4
Feb	0.9	21.0	-12.0	3.9	-1.3	3.1
Mar	2.1	17.0	-10.2	3.7	-0.2	4.5
Apr	3.4	16.4	-5.5	3.0	1.6	5.6
May	5.1	18.0	-4.1	3.1	3.7	6.8
Jun	6.8	20.6	-0.1	3.6	5.7	9.1
Jul	10.7	23.5	2.0	3.2	9.6	12.9
Aug	12.9	24.0	4.0	2.9	11.7	14.2
Sep	12.1	23.3	3.5	3.1	10.7	13.7
Oct	8.8	22.8	1.1	3.0	7.3	10.2
Nov	5.9	20.6	-5.5	3.4	4.5	7.4
Dec	3.3	18.8	-8.4	3.8	1.7	5.0
* January 1960 to December 2016 period						

Figure 5.12 Air Temperature



Air temperatures at sea are strongly influenced by moderating effects of sea temperature, with daily and seasonal variations much smaller than on land. Once offshore, over the potential supply vessel and aircraft route for the Project, conditions are on average fairly consistent with mean values of about 0°C in February and about 15°C in August (Bowyer 1995). Temperatures are slightly warmer by a couple of degrees in winter for the farthest east portions of the route with the influence of warmer Gulf Stream waters. Further information on regional air temperature conditions in this area is provided in the Eastern Newfoundland SEA (Amec 2014), Section 4.1.3.

5.3.3 Precipitation

The ICOADS database contains observations of several precipitation types and thunderstorm occurrence. Every occurrence of a weather state is recorded and categorized as an event based on the type (but not the amount), of precipitation during that event. The frequency of occurrence of the different precipitation types and thunderstorms have been calculated as a percentage of the total monthly and annual weather observations for the same data set described in Section 5.3.2 for air temperature.

A considerable degree of variability of precipitation patterns within localized regions of the Project Area is expected. The statistics shown in Table 5.3 are the percentage of a certain distinct weather state (e.g., rain, thunderstorms, hail, etc.) for all weather reports available on record for that month. The weather states have been consolidated from 50 different ICOADS classifications, separating (without overlap) rain from freezing rain and snow (although some overlap may exist between these states and mixed rain/snow, hail and thunderstorm, which represent a small percentage of the data). The frequency of occurrence – or, the percent of time the given condition(s) occurs in a given month (or annually) - can most closely be characterized as representing unspecified periods of time, for a percentage of all days.

For the Project Area, the data indicate that most of the observed precipitation events are in the form of rain, snow and drizzle, while other precipitation types, such as mixed rain, freezing rain, and hail, occur far less frequently. Rain occurs approximately seven to 14 percent of the time every month of the year, while snow is most likely to occur in December, January and February (Table 5.3, Figure 5.13). Freezing rain is relatively infrequent in this area, occurring less than one percent of the time during any given month, and does not occur at all between July and November. Thunderstorms are the main generating mechanism of hail, and therefore the observation of hail is expected during thunderstorms. Figure 5.14 shows that hail and thunderstorms indeed occur with similarly low frequencies. There is a year-round potential for thunderstorms and hail, but the frequency of occurrence is less than one percent.

Table 5.3 Frequency of Occurrence (Percent) of Precipitation and Thunderstorms

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Jan	9.6	0.5	1.4	9.4	0.2	0.0
Feb	10.7	0.1	1.1	10.4	0.4	0.1
Mar	9.3	0.0	0.7	6.7	0.3	0.0
Apr	7.0	0.1	0.8	3.6	0.2	0.0
May	8.4	0.1	0.2	1.4	0.1	0.0
Jun	11.8	0.1	0.0	0.1	0.1	0.1
Jul	9.6	0.0	0.0	0.0	0.1	0.1
Aug	10.5	0.0	0.3	0.3	0.0	0.3
Sep	11.1	0.0	0.2	0.0	0.0	0.0
Oct	14.3	0.0	0.0	0.1	0.2	0.0
Nov	12.6	0.0	0.4	1.5	0.0	0.0
Dec	9.7	0.2	1.1	8.6	0.3	0.0
Annual	10.0	0.1	0.5	3.8	0.2	0.0

Figure 5.13 Frequency of Occurrence (Percent) of Precipitation by Type

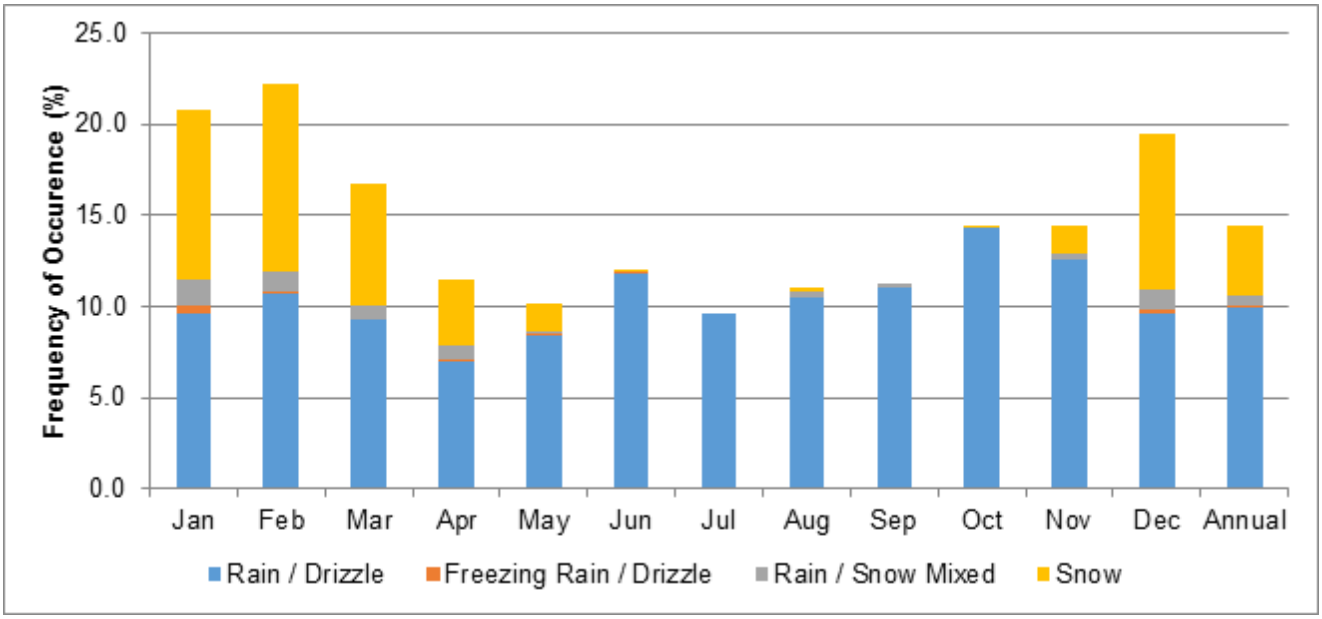
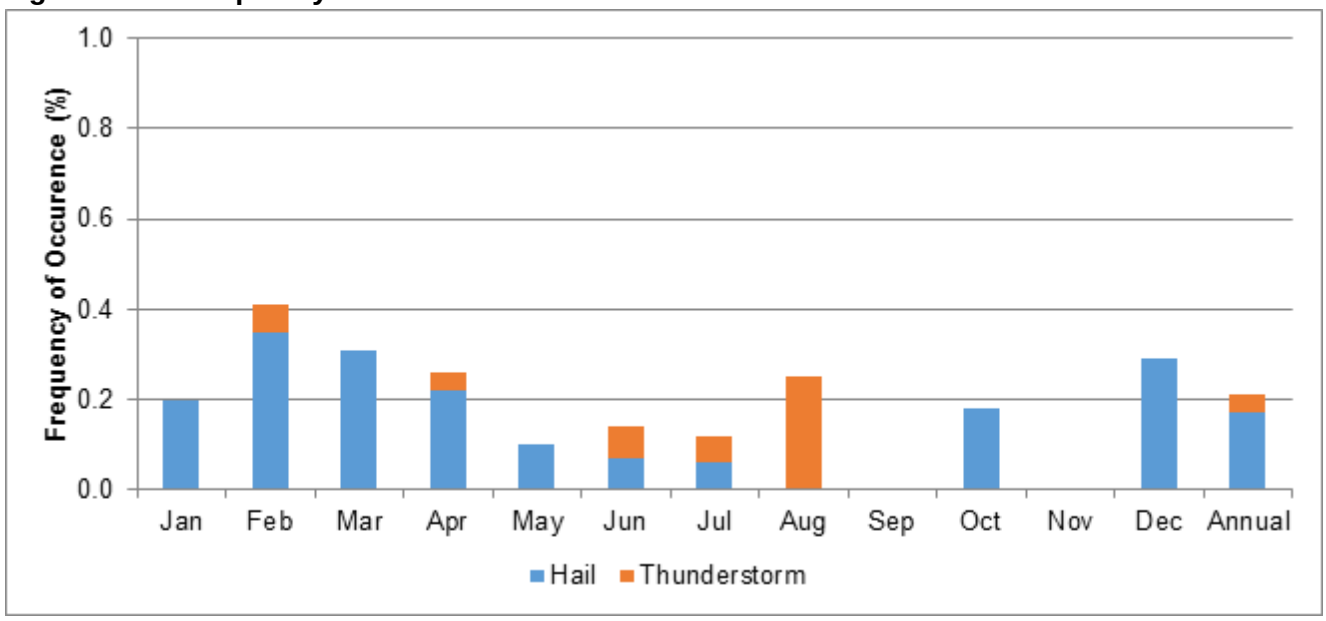


Figure 5.14 Frequency of Occurrence of Thunderstorm and Hail



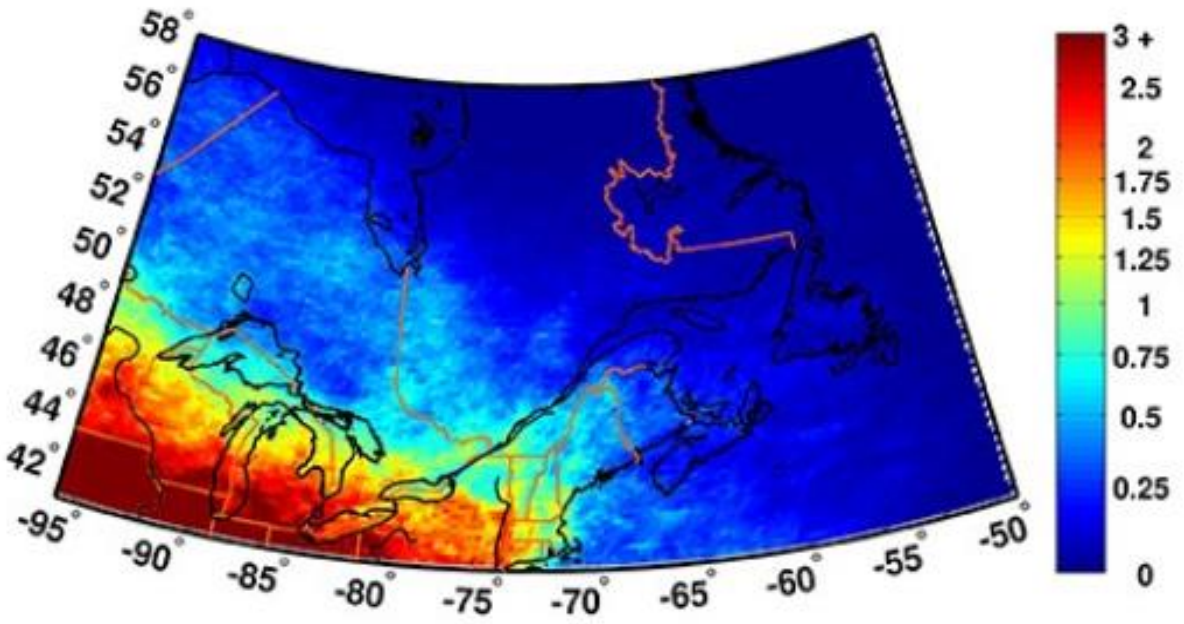
Precipitation along the potential vessel and aircraft route to the Project Area can be experienced any time of year, with it being 3-4 times more likely in winter than in summer. Further information on the regional precipitation characteristics of this area is provided in the Eastern Newfoundland SEA (Amec 2014), Section 4.1.3.

Lightning is an electrical discharge most commonly produced in thunderstorms, usually accompanied by thunder. It occurs in clouds with vigorous convection where enough electrical charge is separated through the movement of cloud droplets and precipitation particles. By its nature, lightning is a very localised and random phenomenon and, as a result, it is one which is difficult to accurately represent in numerical models. Measurements are available from the Canadian Lightning Detection Network;

however, this is a land based network, with coverage just to Eastern Newfoundland with the Grand Banks on the far eastern edge of the network; therefore, there are no lightning data available for the Project Area itself. Nevertheless, the available lightning statistics from Environment and Climate Change Canada for Eastern Canada do provide some indication of conditions over portions of the Project Area and/or potential vessel and aircraft transit route.

On average, compared with other locations on land, there is not much lightning offshore. Figure 5.15 shows the average lightning flash density (flashes per km^2/year) for Eastern Canada with values of 0.1 for Newfoundland and Labrador, and for the offshore. This is compared with flash density values of, for example, 2.1 for Ontario southwest between the Great Lakes, 0.5 for New Brunswick and 0.25 for Nova Scotia (Environment and Climate Change Canada 2016).

Figure 5.15 Average Flash Density (Flashes per km^2 / year) for Eastern Canada (1999-2013)_



Source: Environment and Climate Change Canada (2016)

5.3.4 Fog and Visibility

The Project Area and surrounding areas have some of the highest occurrence rates of marine fog in North America, which in these regions is often of the advection type. Advection fog is formed when warm moist air flows over a cold surface such as the cold Northwest Atlantic Ocean, and can persist for days or weeks. This type of fog is most prevalent in spring and summer. Visibility is affected by the presence of fog, the number of daylight hours, as well as frequency and type of precipitation. For this characterization, visibility from the ICOADS dataset (observations span 1960 to 2016, for the entire Project Area) has been classified as very poor (less than 0.5 km), poor (0.5 to 2 km), fair (2 to 10 km) or good (over 10 km).

The monthly and annual frequencies of occurrence for these visibility classes are shown in Table 5.4 and Figure 5.16. Fog and visibility conditions and seasonal fluctuations are expected to vary

considerably across the Project Area, along with air temperatures and precipitation rates. Therefore, site-specific conditions and the possible implications of these would have to be characterized from local visibility datasets for any project- and activity-specific planning and analysis.

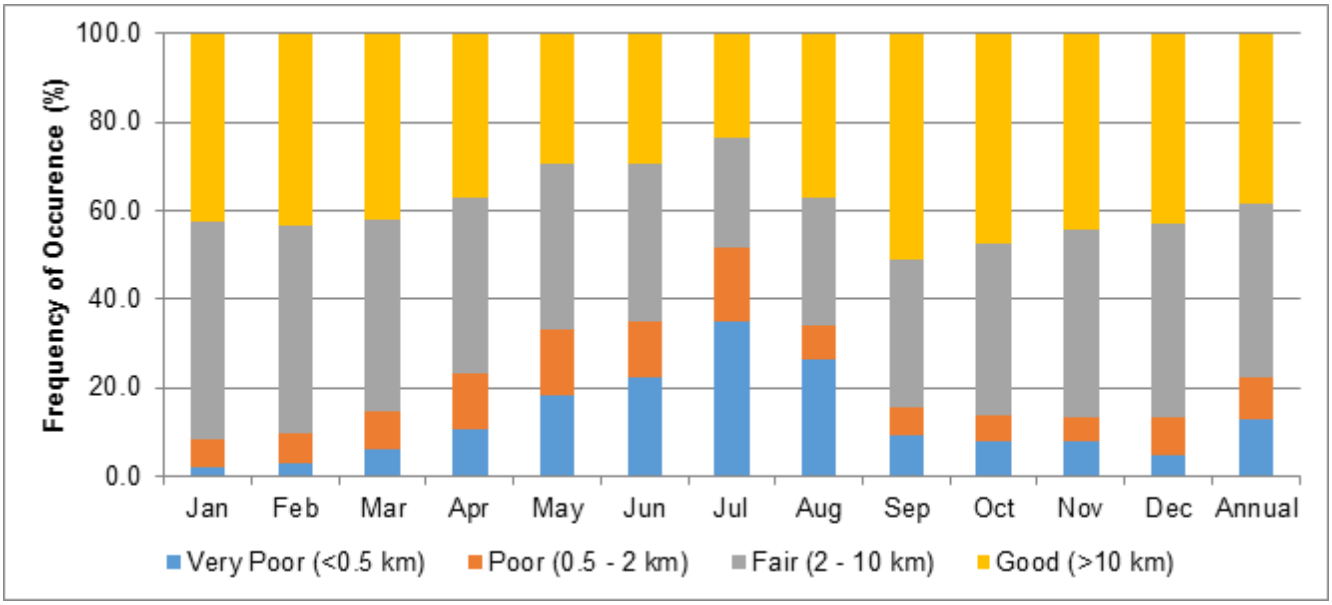
As shown in Table 5.4 and Figure 5.16, visibility within the Project Area varies considerably throughout the year. Good or fair visibility combined occur about 77.5 percent of the time annually. Good visibility (greater than 10 km) is most frequent during the fall, and least frequent in spring and summer. Visibility is the worst in July with conditions being very poor or poor over half the time (52 percent). Annually, visibility is very poor 12.7 percent of time, poor 9.8 percent of the time, fair 39.1 percent of the time, and good 38.4 percent of the time.

Table 5.4 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility

Month	Very Poor (<0.5 km)	Poor (0.5 – 2 km)	Fair (2 – 10 km)	Good (>10 km)
Jan	2.2	6.1	49.0	42.7
Feb	2.8	6.9	47.0	43.4
Mar	5.9	8.9	43.2	42.0
Apr	10.7	12.6	39.6	37.1
May	18.4	14.5	37.6	29.5
Jun	22.4	12.4	35.9	29.3
Jul	35.1	16.6	24.9	23.4
Aug	26.6	7.6	29.0	37.0
Sep	9.3	6.0	33.7	51.0
Oct	8.1	5.7	39.0	47.3
Nov	7.7	5.5	42.3	44.5
Dec	4.7	8.7	43.9	42.8
Annual	12.7	9.8	39.1	38.4

Fog can be expected anywhere along the potential vessel and aircraft travel route to the Project Area though is more common over the Grand Banks than farther east in the Project Area. Fog along the route will be most frequent in late spring and early summer. Further information on regional fog and visibility conditions is provided in the Eastern Newfoundland SEA (Amec 2014), Section 4.1.3.

Figure 5.16 Frequency of Occurrence of Visibility



5.4 Air Quality

The existing ambient air quality within the Project Area can be generally categorized as very good, and is likely occasionally and locally influenced by exhaust emissions from marine vessel and aircraft traffic and from the operations of the existing oil production platforms (Hibernia, White Rose, Terra Nova, and Hebron). To characterize the existing ambient air quality of the region, data were obtained from the National Pollutant Release Inventory (NPRI) Reporting program for criteria air contaminants (i.e. carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), TPM, particulate matter less than 10 and 2.5 mircrons in diameter ($PM_{2.5}$, PM_{10}), and volatile organic compounds (VOCs)). The NPRI program is regulated under CEPA, and requires each facility meeting specified reporting triggers to report their emissions to ECCC on an annual basis. An overview of the emissions reported from the operation of Hibernia, White Rose, and Terra Nova for the 2015 reporting year are provided in Table 5.5.

Table 5.5 2015 Facility Reported CAC Emissions (NPRI Reporting) – NL Offshore Production Platforms

Facility	Air Emissions (tonnes/year)					
	CO	NO_2	TPM	PM_{10}	$PM_{2.5}$	VOC
Terra Nova	566	2,065	160	154	154	644
Hibernia	841	2,676	253	253	253	254
White Rose	657	958	161	161	160	451
Source: Environment and Climate Change Canada (2016a)						

As the Jeanne d'Arc Basin is not known to contain sour gas, emissions of sulphur dioxide and hydrogen sulphide have not been reported.

Emissions of greenhouse gases from the operation of the existing offshore oil production platforms are also reported on an annual basis to ECCC, through the Greenhouse Gas Emissions Reporting Program

(GHGRP). An overview of the 2015 reported emissions for each of the existing production platforms are provided in Table 5.6.

Table 5.6 2015 Facility Reported GHG Emissions (GHGRP) – NL Offshore Production Platforms

Facility	GHG Emissions (tonnesCO_{2eq}/year)			
	CO_2	CH_4	N_2O	Total
Terra Nova	513,275	25,879	9,275	548,428
Hibernia	471,863	39,523	3,785	515,170
White Rose	483,436	39,837	11,981	535,253
Source: Environment and Climate Change Canada (2017)				

As mentioned above, occasional influences from marine vessel traffic in the Project Area would also affect the air quality at the Project site. Such emissions are regulated by the International Maritime Organization (IMO) through MARPOL.

5.5 Oceanography

This section provides an overview of the primary oceanographic conditions and characteristics of the Project Area. This includes waves, ocean currents, seawater properties (temperature, salinity), and extreme winds and waves.

5.5.1 Waves

For the purpose of the EIS, the wave climate within the Project Area has been characterized by descriptive statistics derived from the MSC50 wind and wave hindcast dataset for the 1962-2015 period (Section 5.3.1). The wave hindcast was conducted by using the wind field reanalysis to force a third generation wave model (Swail et al 2006) over the North Atlantic Ocean. The model used was Oceanweather's OWI-3G, adopted onto a 0.5 degree grid on a basin-wide scale. Inscribed in the 0.5 degree model was a further refined 0.1 degree shallow water implementation of the OWI-3G model, which allowed for shallow water effects to be accounted for in the maritime region. The MSC50 methodology and results have been extensively documented and validated (Swail and Cox 2000; Woolf et al 2002; Caires et al 2004).

As presented earlier for wind conditions, an MSC50 grid point location (Figure 5.9) was selected to provide representative wave conditions for the Project Area. This is consistent with a regional overview for general illustration and EA purposes, rather than detailed oceanographic information for design or operational purposes.

The wave climate is described in terms of the significant wave height (Hs, defined as four times the square root of the total variance of the wave energy spectrum), and the peak wave spectral period (Tp, defined as the period of waves with the highest contribution to the energy spectrum). Ocean waves result from effects of wind on the air/water interface. The winds are due to the dominant local and regional weather systems encountered and exhibits a pronounced seasonal variability. Wind waves (or sea) will be generated in the immediate area of wind, developing quickly within an hour. Swell are what remains of the wind waves after they propagate away from where they have been generated. Swell are long waves which contain a lot of wave energy, and can take days to subside. The range of wave

periods for wind waves and swell overlap considerably with wind waves having periods up to 15 s for very large winds speeds, while swell of only a few seconds is possible.

Table 5.7 presents monthly significant wave height and peak wave period statistics representative for the Project Area; monthly and annual wave roses are presented in Figure 5.17 and Figure 5.18.

Table 5.7 Wave Statistics, MSC50 Node M6012613 (1962 – 2015)

Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Hs (m)	4.5	4.0	3.3	2.8	2.3	2.0	1.7	1.9	2.5	3.1	3.6	4.2	3.0
Mean Tp (s)	10.7	10.0	9.1	9.2	8.6	8.1	7.8	7.9	9.0	9.5	9.9	10.6	9.2
Most Frequent Direction (from)	W	W	SW	SW	SW	SW	SW	SW	SW	NW	NW	NW	SW
Maximum Hs (m)	14.8	15.1	12.6	11.0	11.5	10.8	7.1	8.8	12.8	12.6	12.7	14.4	15.1
Tp of max Hs (s)	15.3	16.8	13.7	13.8	14.1	14.0	12.0	12.1	15.2	15.1	14.6	16.0	16.8
Maximum Tp (s)	17.3	17.1	24.5	17.0	17.4	20.9	17.4	17.4	17.6	17.5	17.1	17.3	24.5
Direction of max Hs (from)	W	SW	NW	NW	NW	NW	S	SW	SW	W	W	NW	SW

Monthly mean significant wave heights range from about 1.7 m in July to 4.5 m in January with an annual mean of 3.0 m. As shown in Table 5.7, the most severe sea states occur in December through February when maximum significant wave heights exceed 14.0 m and reach 15.1 m (in December). The largest waves are from the southwest through northwest directions with associated peak periods in the 15 to 17 s range. In contrast, the maximum significant wave height at 7.1 m is lowest in July, with an associated peak period of 12 s.

Figure 5.17 Monthly Wave Roses, MSC50 Node M6012613 (1962 – 2015)

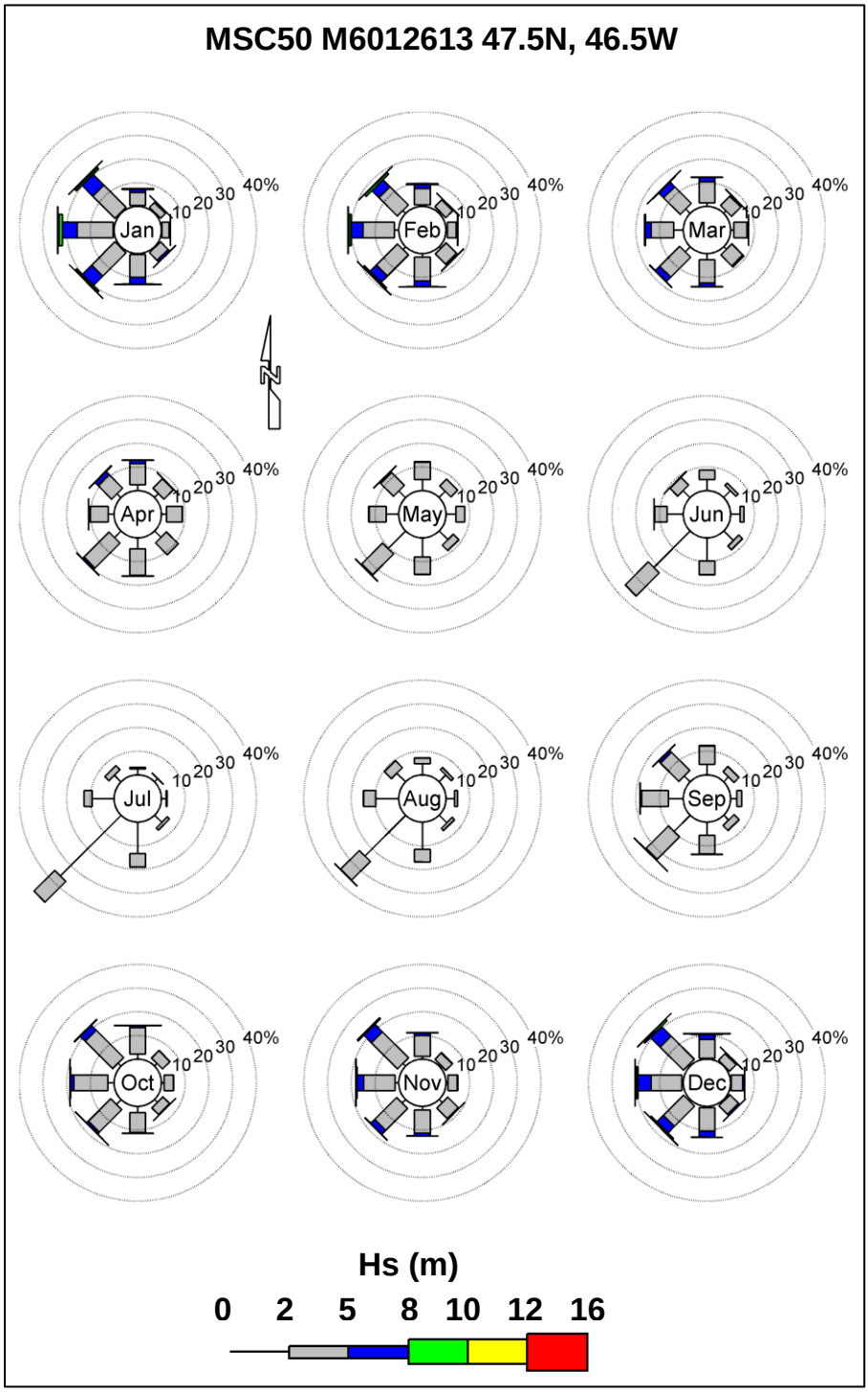
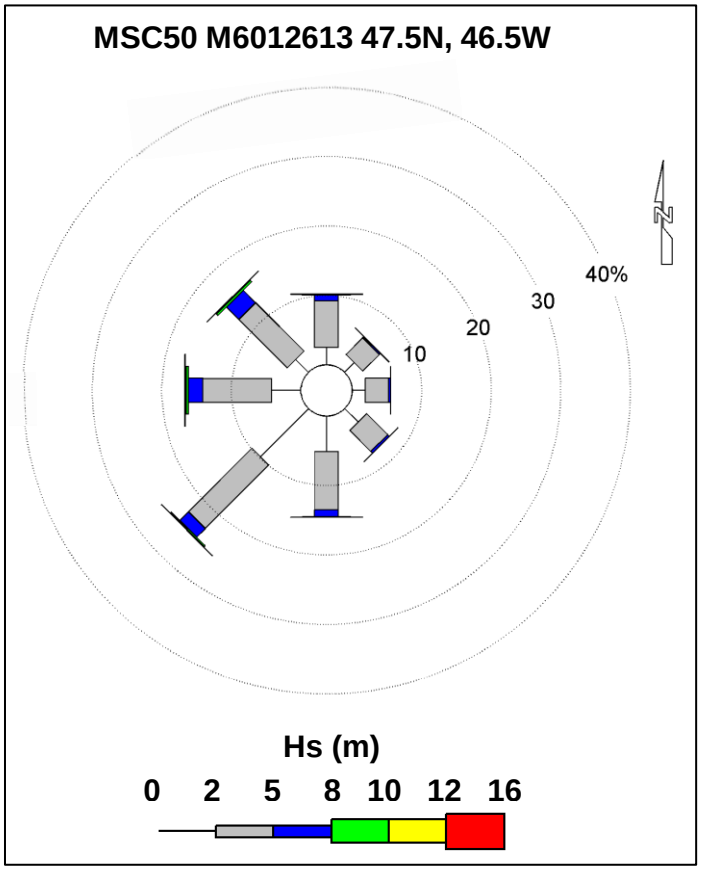


Figure 5.18 Annual Wave Rose, MSC50 Node M6012613 (1962 – 2015)



The range of wave conditions experienced along the potential vessel and aircraft travel routes from Eastern Newfoundland to the Project Area will be similar to those experienced farther offshore, although with wave heights expected to be somewhat lower closer to shore. Annually, mean wave heights are about 2 m near St. John's compared with 3 to 3.5 m near the eastern portions of the Project Area. During fall and winter months, average wave heights can be expected to be 1.5 m higher offshore than near St. John's; corresponding maximum wave heights can be expected to be at least 2 m higher. Further information on the regional wave environment in this area is provided in the Eastern Newfoundland SEA (Amec 2014), Section 4.1.4.

5.5.2 Ocean Currents

The cold Labrador Current dominates the general circulation over the Eastern Newfoundland Offshore Area. The Labrador Current is divided into two streams: 1) an inshore branch that flows along the coast on the continental shelf; and 2) an offshore branch that flows along the outer edge of the Grand Banks (Figure 5.7). The Labrador Current's inshore branch tends to flow mainly in the Avalon Channel along the coast of the Avalon Peninsula but may sometimes also spread farther out on the Grand Banks. The offshore branch flows over the upper Continental Slope at depth, and through the 1,300 m deep Flemish Pass. The offshore Labrador Current (which remains bathymetrically trapped over the upper Continental Slope) has average speeds of about 40 cm/s carrying approximately 85 percent of the total transport, mainly between the 400 and 1,200 m isobaths (Lazier and Wright 1993). Over areas of the Grand Banks with water depths less than 100 m, the mean currents are generally weak (less than 10 cm/s) and flow southward, dominated by wind-induced and tidal current variability (Seaconsult Ltd. 1988).

Near the Project Area, in the vicinity of the Flemish Pass, the Labrador Current divides into two branches with the main branch flowing southwards as Slope Water Current and the side branch flowing up to the east-northeast clockwise past the Sackville Spur and north-eastward around the Flemish Cap. The cores of the currents are located at an average depth of 100 m. This is well-illustrated in Figures 5.19 to 5.20 below which show current transects (currents at depth approximately 45-65 m) from a recent Fisheries and Oceans Canada oceanographic program in the Sackville Spur and Flemish Pass regions in 2013-2014. This field program, with funding from the Environmental Studies Research Fund (ESRF), had the objective of studying ocean current variability and dispersion in the vicinity of the Sackville Spur as well as to characterize some of the benthic habitat for assessment of vulnerable marine ecosystems (Greenan et al 2016).

The oceanographic data from the DFO (Greenan et al 2016) program includes shipboard CTD (conductivity, temperature and dissolved oxygen), lowered Acoustic Doppler Current Profiler (ADCP), vessel-mounted ADCP and water samples during two cruises in July 2013 and 2014. Moorings were deployed at three locations (as shown in Figures 5.19 and 5.20) including one (Sackville Spur West, 1841) 45 km to the north of Project Area and one 16 km west of the southwest corner of the Project Area (Flemish Pass, 1842). A third mooring (Sackville Spur East, 1840) was located about 92 km to the northeast of the Project Area. The Ocean Data Inventory (ODI) current statistics reported below include measurements from 12 RCM11 single-point current meters from the two Sackville Spur moorings (six RCM11s at each location).

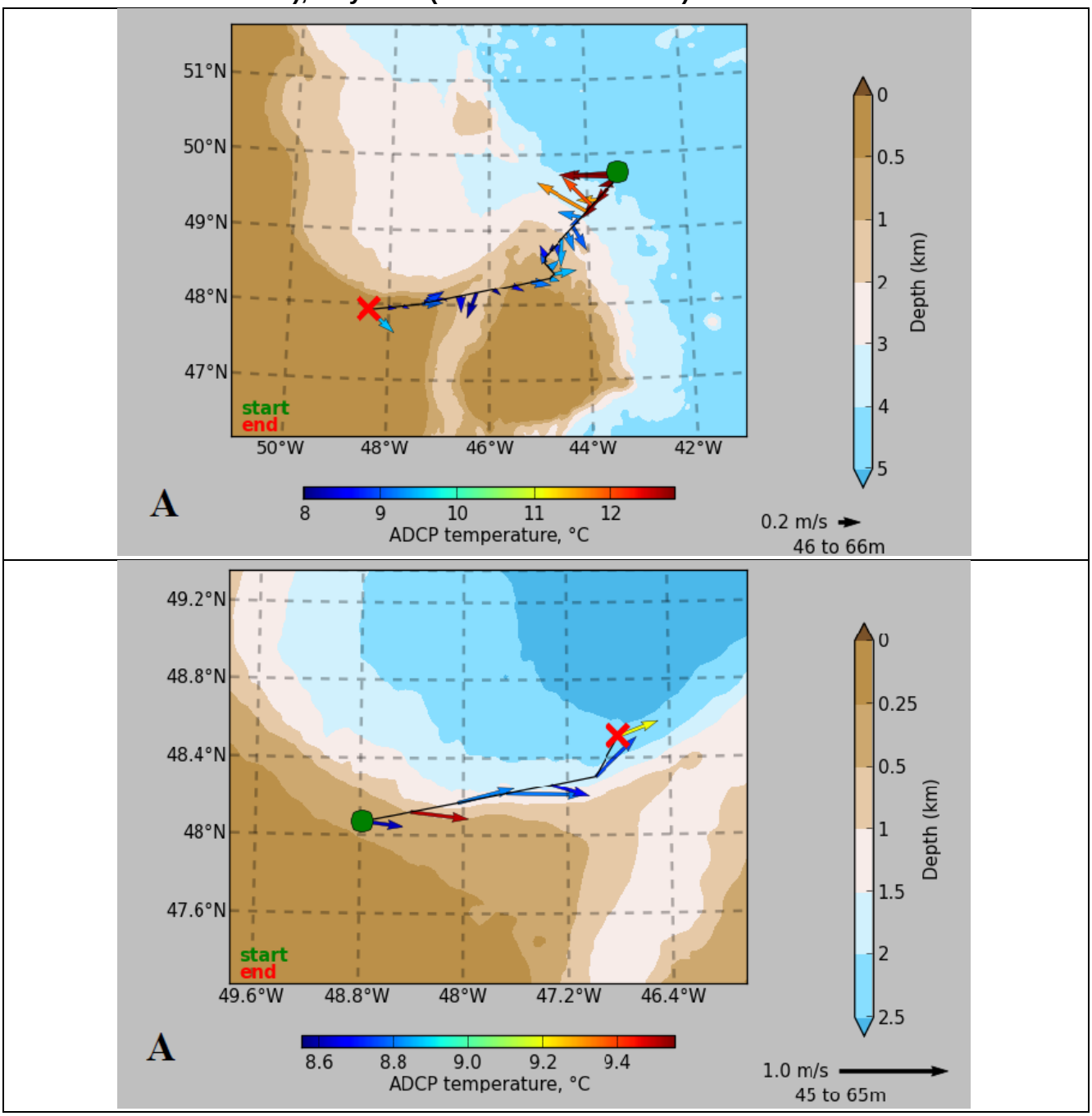
For the purposes of this overview, statistics for both current meter near around the Project Area and modelled currents in the Project Area are reported. The primary data source is the Bedford Institute of Oceanography (BIO) ODI database (Gregory 2004). The database consists of all current meter records that have a record length of at least five days within a given month.

In anticipation that measurements may be relatively limited within the Project Area boundaries, the database was queried for a surrounding area extending from 46.4°N to 49°N, 45.5°W to 47.5°W (DFO 2017). While there are no measurements directly within the Project Area, there are a total of 228 monthly current statistic records from 33 deployments at 28 depths at 11 locations. These are located solely to the west and southwest of the Project Area on the eastern slopes of the Grand Banks and Flemish Pass, and north of the Project Area along the Sackville Spur. A summary of these data by depth, noting the number of instrument records, data duration, and mean and maximum current speed is presented in Table 5.8.

Table 5.8 ODI Ocean Current Statistics Summary (46.4° to 49°N, 45.5° to 47.5°W)

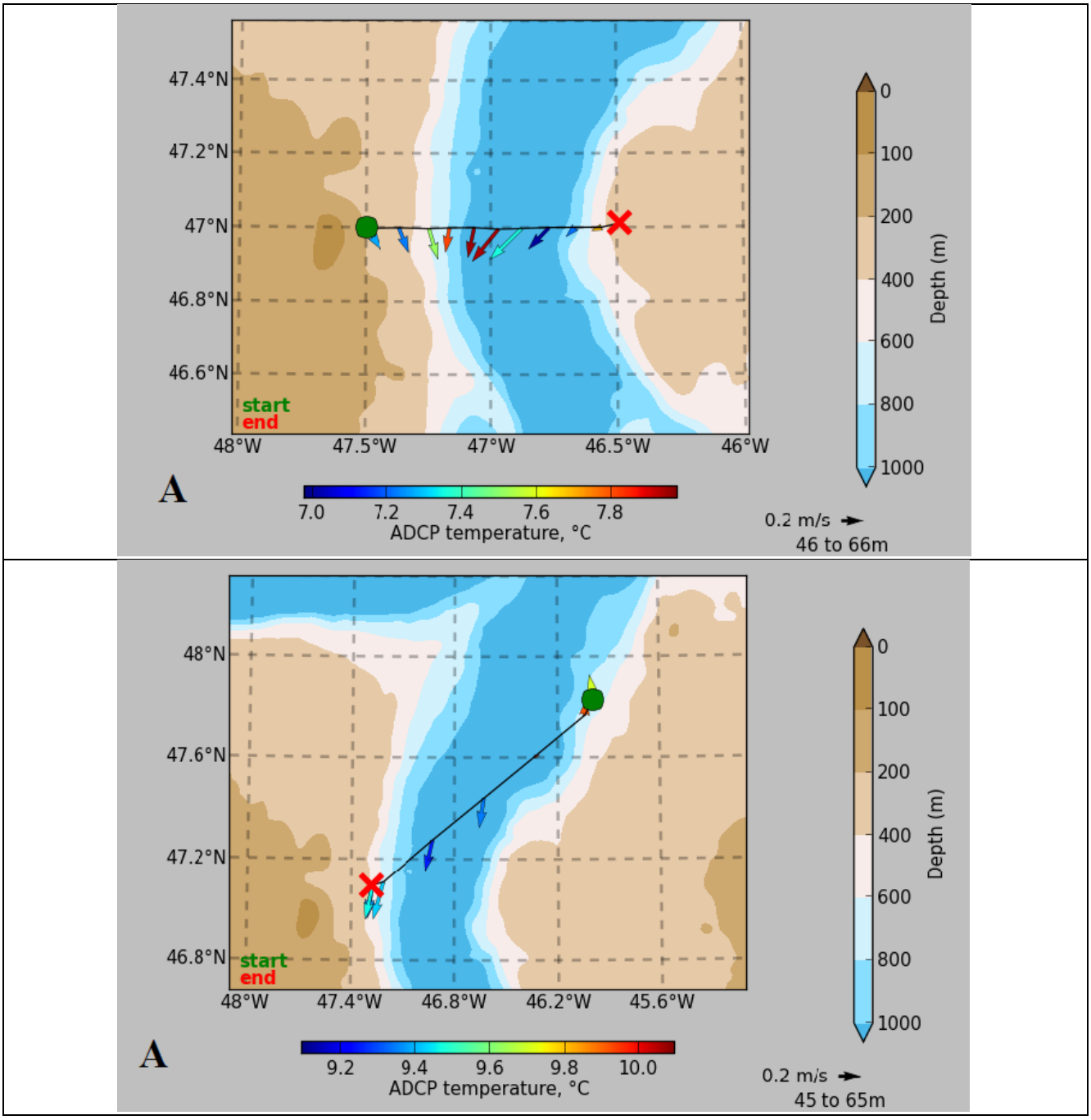
Depth	Number of Instrument Records	Number of Data Months	Mean Current Speed (cm/s)	Maximum Current Speed (cm/s)
0 to 100 m	7	5.1	22.5	63.5
100 to 200 m	14	9.9	40.5	96.8
200 to 500 m	61	51.7	14.7	61.7
500 to 1,000 m	94	84.7	15.3	69.0
Greater than 1,000 m	52	49.3	18.5	59.6
Total	228	200.7	17.6	96.8

Figure 5.19 Sackville Spur Region, VM ADCP Depth-Averaged Current Speed, July 2013 (Top: HUD2013021), July 2014 (Bottom: HUD2013021)



Source: Greenan et al (2016)

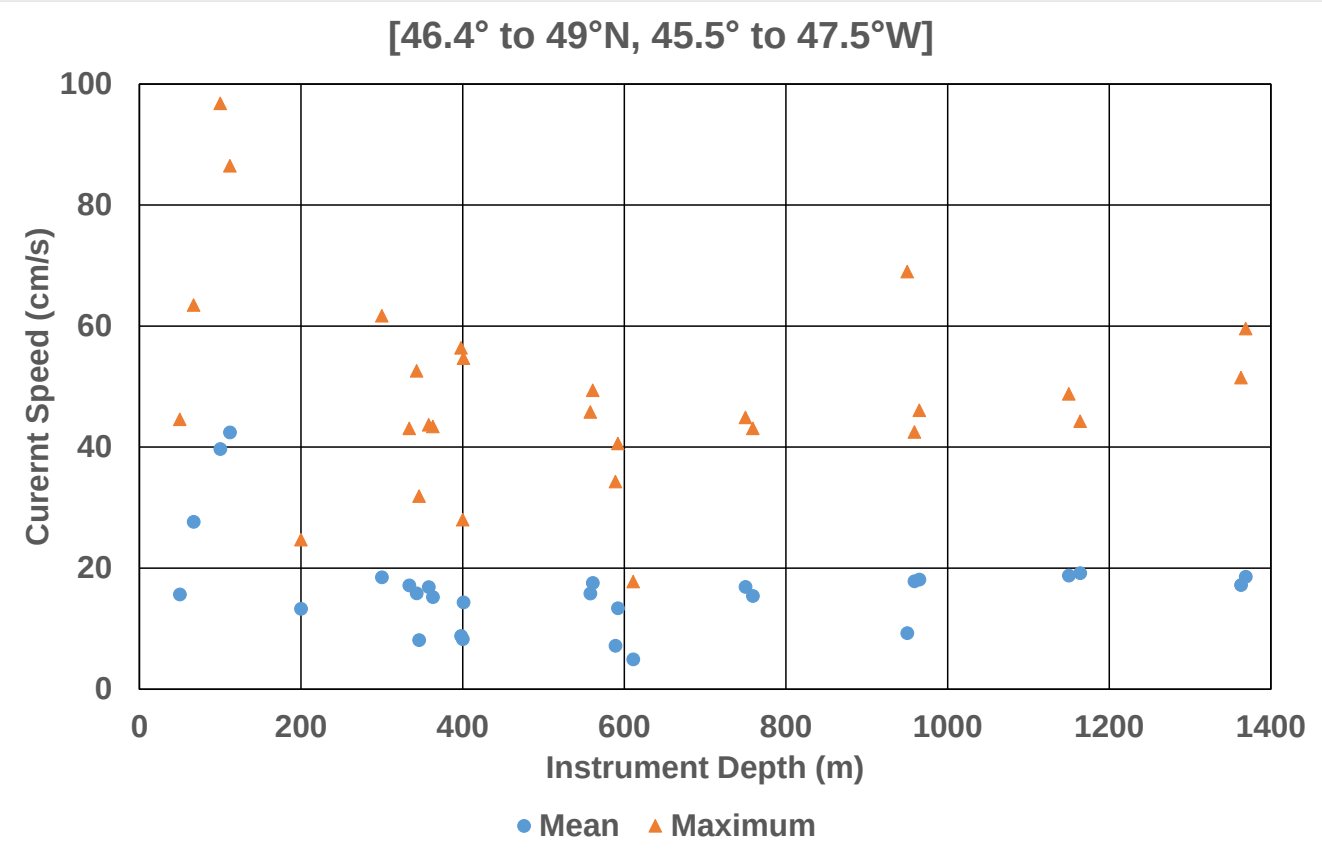
Figure 5.20 Flemish Pass Region, VM ADCP Depth-Averaged Current Speed, July 2013 (Top: HUD2013021), July 2014 (Bottom: HUD2013021)



Source: Greenan et al (2016)

The mean and maximum currents for all 28 depths near the Project Area are presented in Figure 5.21.

Figure 5.21 Mean and Maximum Current Speed



These current measurements have average speeds (for each of the various depth ranges shown in Figure 5.21 above) that range from eight to 42 cm/s for depths up to 400 m and range from five to 19 cm/s at depths of 558 m and above. Maximum current speeds of 97 cm/s were recorded February 1986, along the slope, eight kilometers southwest of the Project Area boundary, at location 46.9835°N, 47.13885°W, at an instrument depth of 100 m. The deepest maximum current speeds are 60 cm/s measured near-bottom (1,369 m) located along the Sackville Spur at a mooring water depth of 1,400 m.

As part of the EIS, drill cuttings modelling was completed for two example well locations in the Project Area (see Section 8.3.4 and Appendix D). Ocean currents for the model were derived from seasonal average currents at near-surface, mid-depth and near-bottom depths through the water column using the WebDrogue CECOM (Canadian East Coast Ocean Model) model (DFO 2015a), and tidal predictions for a full year derived from the WebTide model (DFO 2015b). The two locations were shown previously in Figure 5.9. The model yields currents at five depth levels: surface, 100 m, 500 m, 1,000 m and bottom.

Tables 5.9 and 5.10 present monthly near-surface, mid-depth and near-bottom current statistics for the two locations, one location in EL 1144 on the northwestern slopes of the Flemish Pass at a water depth of 1,137 m, the other in EL 1150 on the western slopes of the Flemish Pass at a water depth of 387 m. On the western side of the Flemish Pass at the modelled EL 1144 location, near-surface (at the surface)

mean current speeds range from about 2 cm/s in summer to 8 cm/s in fall, with maximum values ranging from 5 cm/s in summer to 12 cm/s in fall. At greater depths (500 m for mid-depth, 1,000 m for near-bottom), current speeds are about one half to one quarter the near-surface values. For near-bottom, mean currents range from 1 to 3 cm/s with maximum speeds of 3 to 5 cm/s, the largest values again being in the fall. On the eastern side of the Flemish Pass at the modelled EL 1150 location, near-surface (surface) mean current speeds range from about 5 cm/s in summer to 11 cm/s in winter, with maximum values ranging from 10 cm/s in summer to 15 cm/s in winter. At greater depths (100 m for mid-depth and the bottom depth level to characterize near-bottom), current speeds are generally one half to one third the near-surface values. Mid-depth and near-bottom mean currents are 2 to 3 cm/s in all months with maximum speeds ranging from 5 to 7 cm/s, the largest values again being in the winter.

Companion current roses for the three depths at both locations are shown in Figures 5.22 to 5.27. On the western side of the Flemish Pass, at the modelled EL 1144 location (Figures 5.22 to 5.24), currents near-surface are predominantly to the south in all months except summer when flow is to the southeast and south. In the fall and winter at both mid-depth and near-bottom currents generally show a similar pattern of southerly and southwesterly flow. In the spring, currents have a more uniformly distributed flow in all directions. In summer, at mid-depth there is slightly greater occurrence of flow to the north and northeast, while near-bottom currents in summer are slightly more frequent to the western quadrant. On the eastern side of the Flemish Pass, at the modelled EL 1150 location (Figures 5.25 to 5.27), currents near-surface are predominantly to the northeast and east in all months. At mid-depth and near-bottom currents are more uniformly distributed to the north, northeast and east.

Table 5.9 Monthly Current Speed Statistics for EL 1144 Location

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Near-Surface	Min (cm/s)	6	6	6	5	5	5	1	1	1	8	8	7
	Mean (cm/s)	8	8	8	7	7	7	2	2	2	9	9	9
	Max (cm/s)	10	10	10	9	9	9	5	5	5	12	12	12
Mid-Depth	Min (cm/s)	1	1	1	0.1	0.1	0.03	0.1	0.1	0.1	2	2	2
	Mean (cm/s)	3	3	3	1	1	1	1	1	1	4	4	4
	Max (cm/s)	6	6	6	3	3	3	3	3	3	6	6	7
Near-Bottom	Min (cm/s)	0.1	0.1	0.1	0.1	0.02	0.1	0.1	0.1	0.01	1	1	1
	Mean (cm/s)	2	2	2	1	1	1	1	1	1	3	3	3
	Max (cm/s)	4	4	4	3	3	3	3	3	3	5	5	5

Table 5.10 Monthly Current Speed Statistics for EL 1150 Location

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Near-Surface	Min (cm/s)	8	8	8	5	5	6	1	1	1	5	5	5
	Mean (cm/s)	11	11	11	9	9	9	5	5	5	8	8	8
	Max (cm/s)	15	15	15	13	13	13	10	10	10	12	12	12
Mid-Depth	Min (cm/s)	0.3	1	1	0.3	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2
	Mean (cm/s)	3	3	3	3	3	3	2	2	2	3	3	3
	Max (cm/s)	7	7	7	7	7	7	6	6	6	6	6	6
Near-Bottom	Min (cm/s)	0.1	0.3	0.1	0.1	0.04	0.1	0.01	0.02	0.1	0.3	0.1	0.1
	Mean (cm/s)	3	3	3	2	2	2	2	2	2	2	2	2
	Max (cm/s)	7	7	7	6	5	6	6	6	6	5	5	5

Figure 5.22 Monthly, Near-Surface, Current Roses, EL 1144 Location

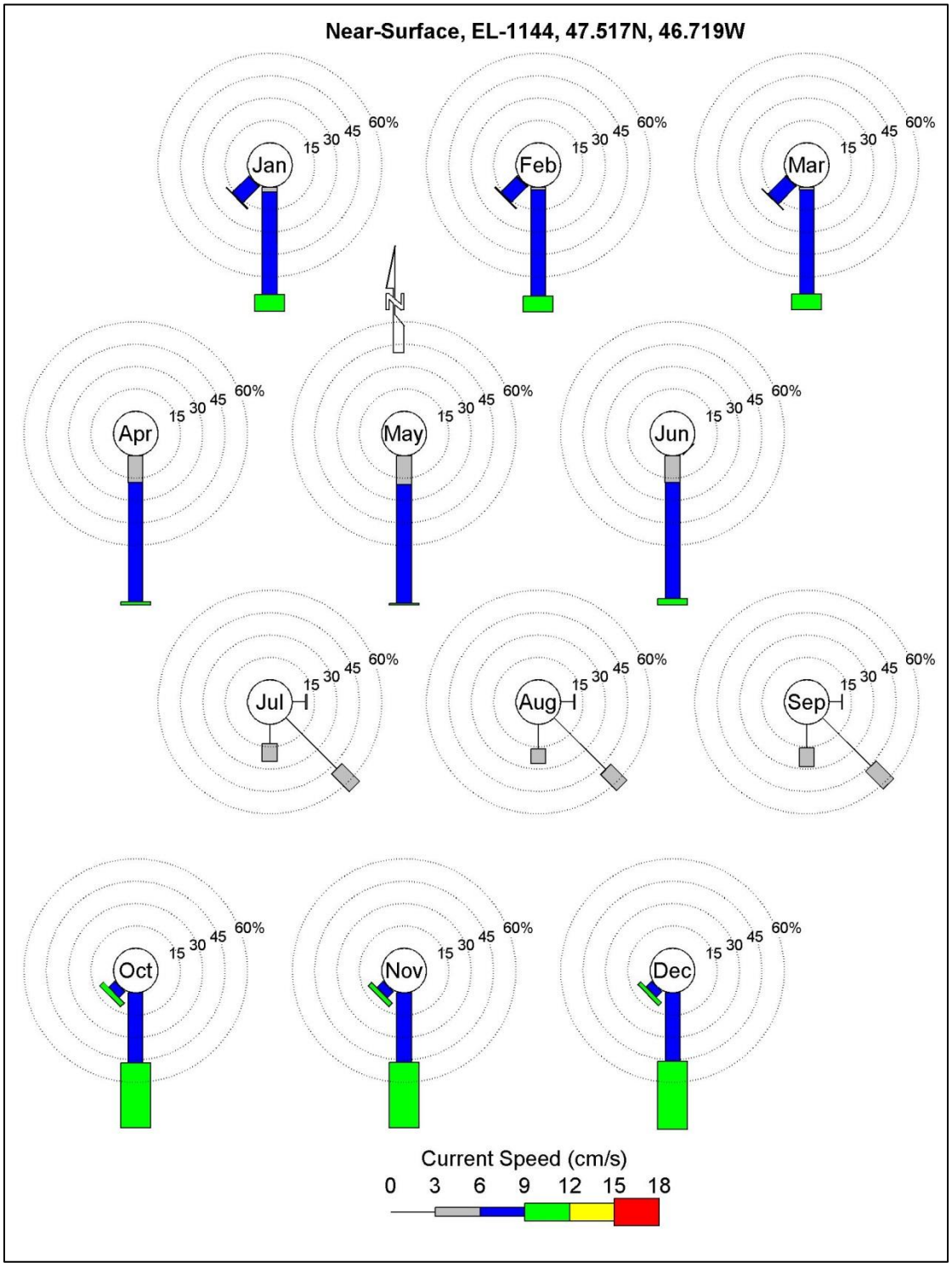


Figure 5.23 Monthly, Mid-Depth, Current Roses, EL 1144 Location

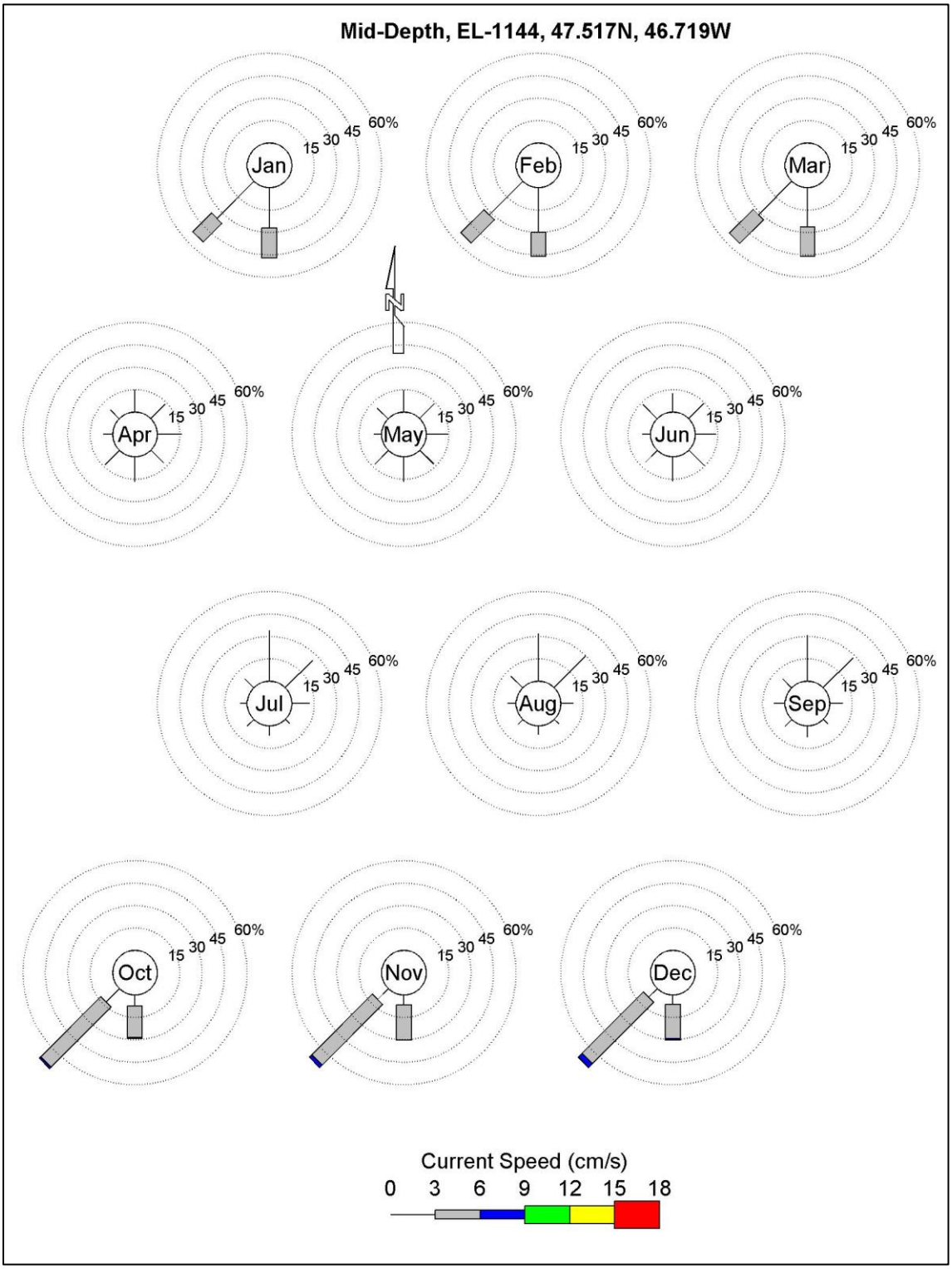


Figure 5.24 Monthly, Near-Bottom, Current Roses, EL 1144 Location

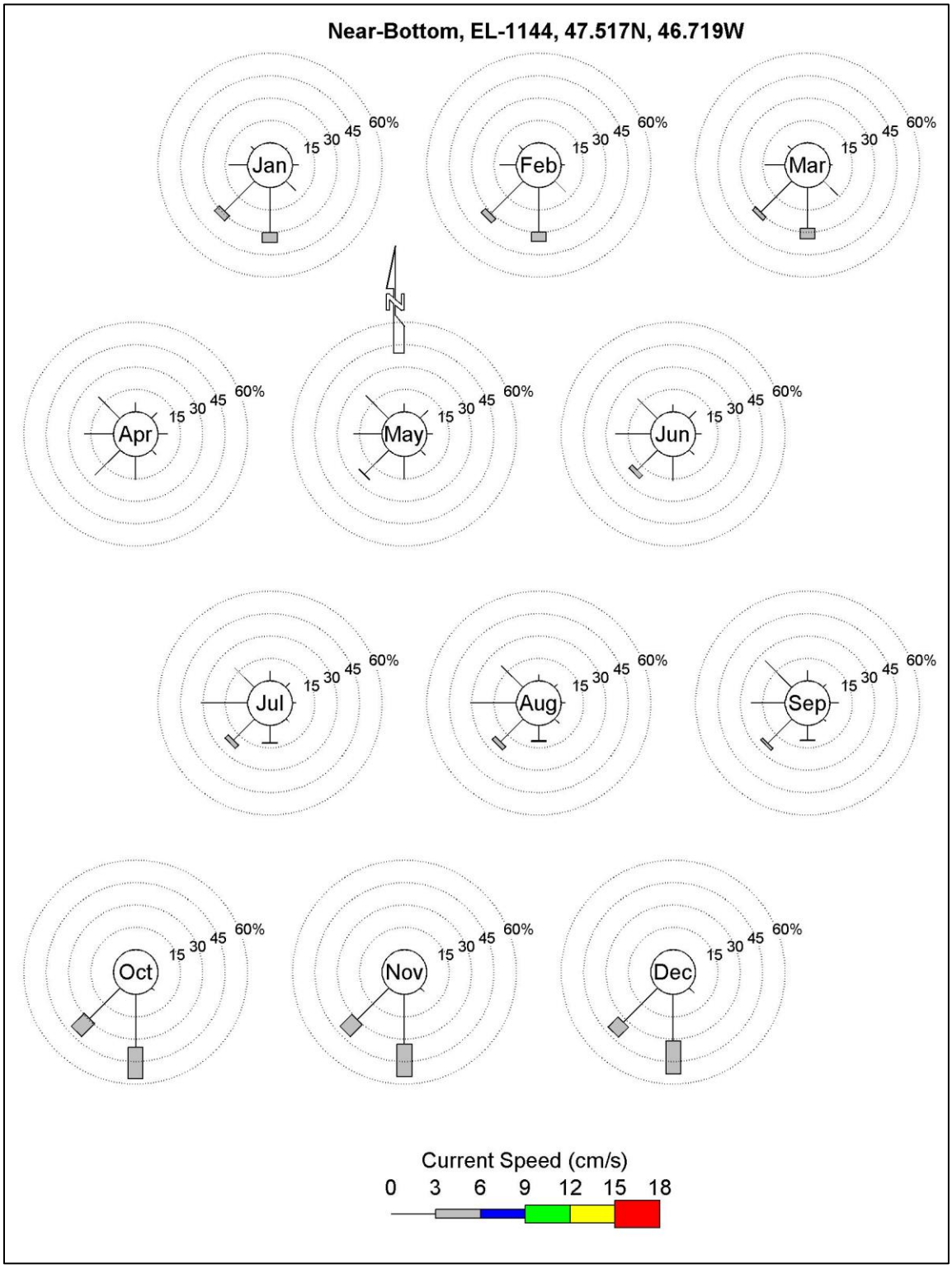


Figure 5.25 Monthly, Near-Surface, Current Roses, EL 1150 Location

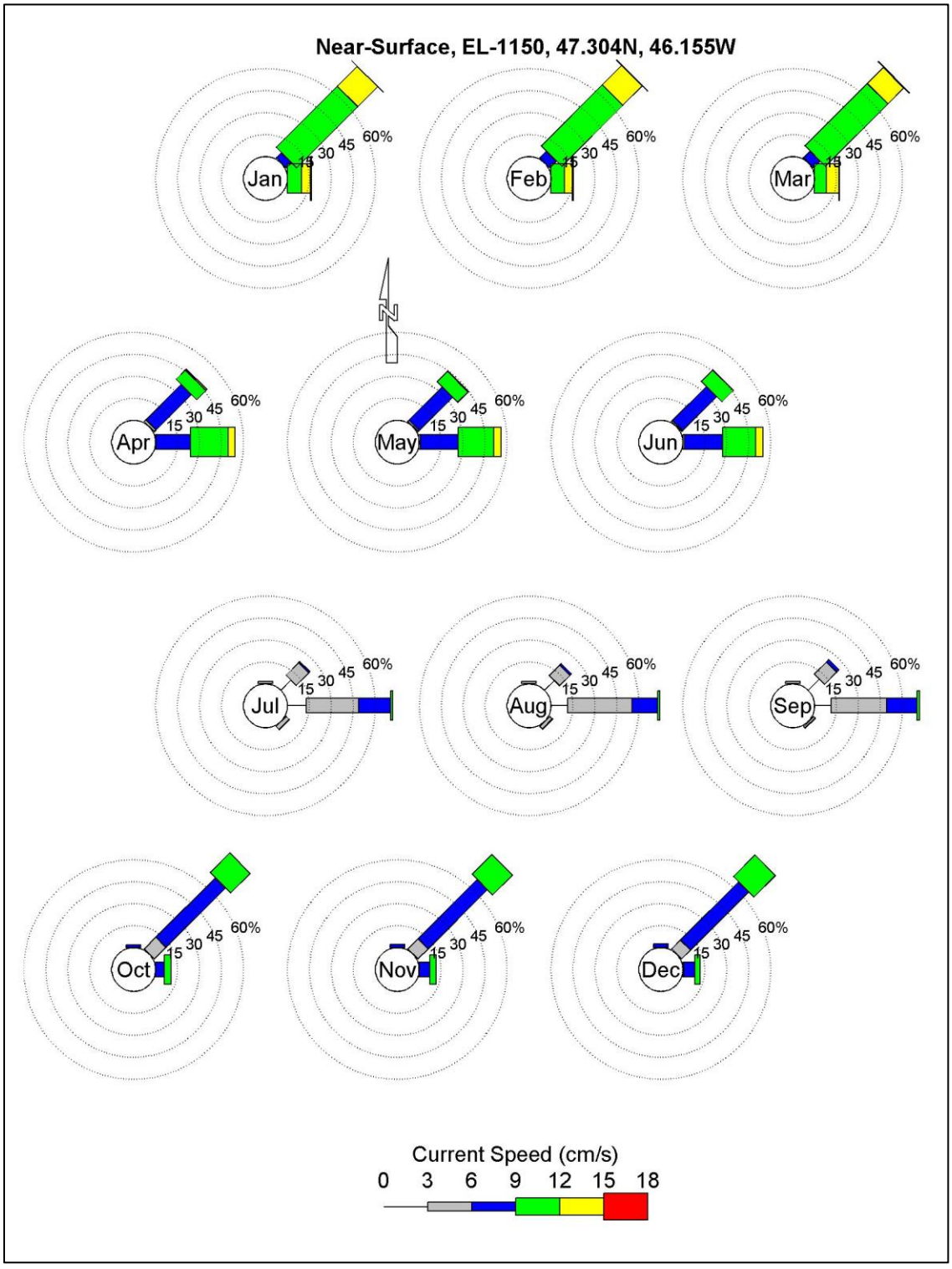


Figure 5.26 Monthly, Mid-Depth, Current Roses, EL 1150 Location

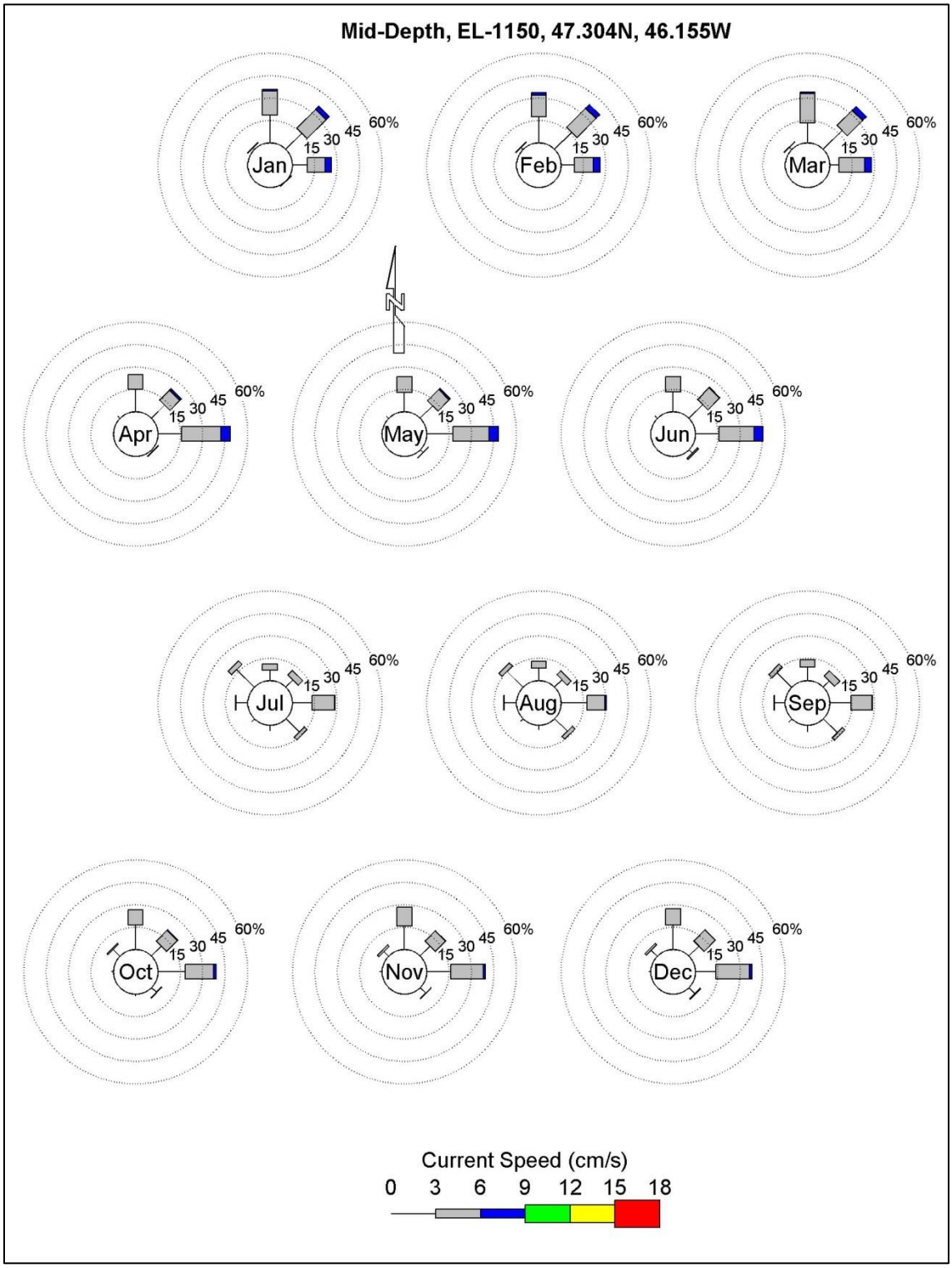
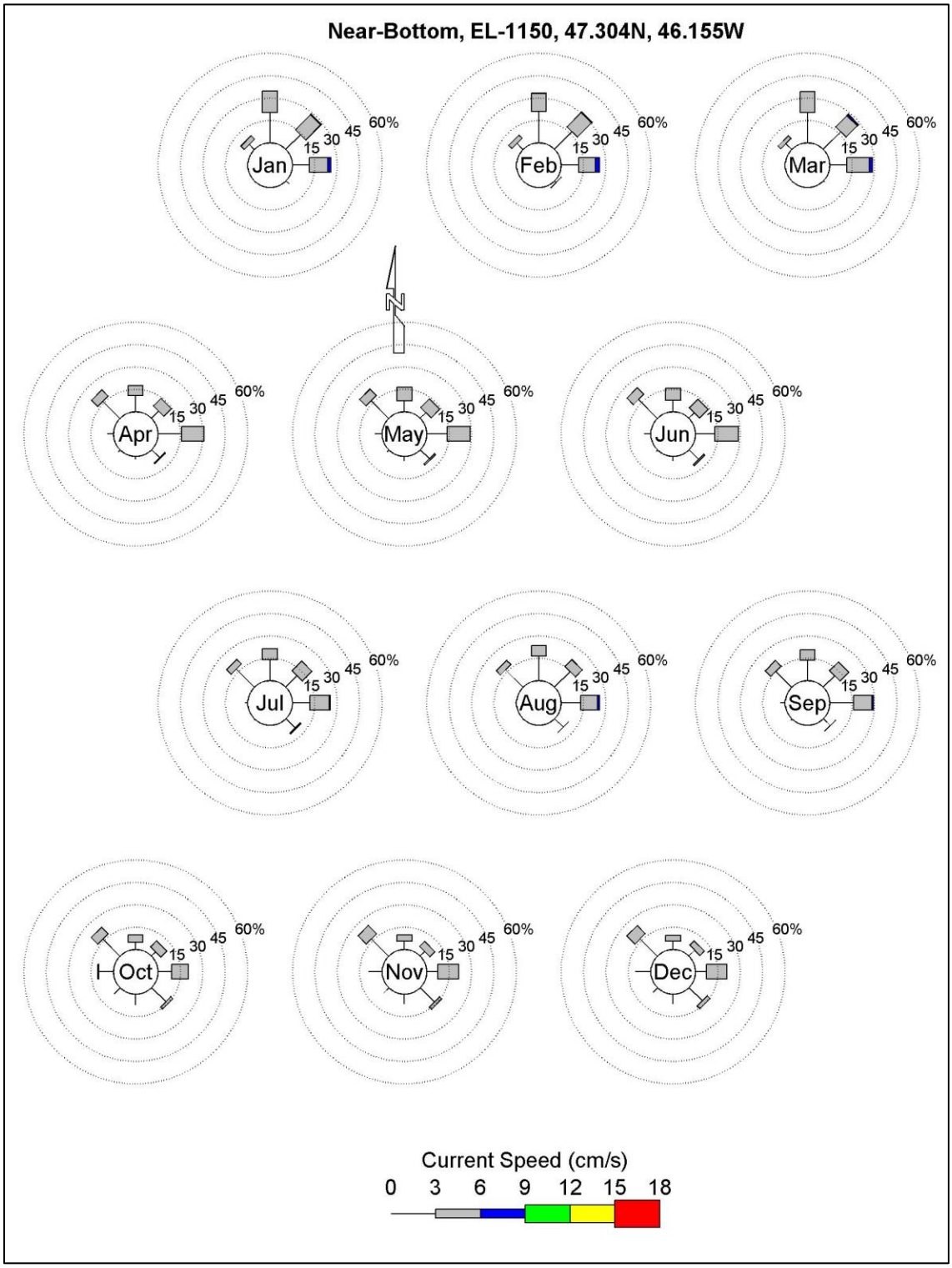


Figure 5.27 Monthly, Near-Bottom, Current Roses, EL 1150 Location



Longshore drift processes deal with transport of pebbles and sand along coastlines. As indicated in Figure 5.4 (Seabed Features) the seabed near the Avalon Peninsula is generally made of two textures. Immediately nearshore the seabed is muddy sand (80 to 90 percent sand). Slightly farther offshore the

seabed is sand (greater than 90 percent sand) with patchy outcrops of greater than 50 percent gravel. Together, these conditions indicate that some erosion and deposition are possible along the shoreline.

5.5.3 Extreme Events

While each of the oceanographic and climatological parameters presented above have the potential to affect the planning and execution of marine operations, the potential occurrence of extreme winds and waves associated with severe storm events is of particular interest in that regard.

To estimate extreme wind and wave conditions, an extreme value analysis was performed using the MSC50 hindcast to determine the highest expected values for wind speed, and significant wave height. The analysis was based on the Gumbel distribution to which the data were fitted using the maximum likelihood method. The analysis includes both tropical and extra-tropical storms over the entire period. Extreme values were computed for four different return periods: 1, 10, 50 and 100 years (Table 5.11).

Table 5.11 Extreme Wind and Wave Estimates, MSC50 Node M6012613 (1962–2015)

Return Period (years)	1	10	50	100
Significant Wave Height (m)	11.6 +/- 0.2	14.1 +/- 0.5	15.9 +/- 0.7	16.7 +/- 0.8
Wind Speed (m/s)	25.6 +/- 0.3	29.6 +/- 0.9	32.6 +/- 1.3	33.8 +/- 1.4

5.5.4 Seawater Properties (Temperature, Salinity, pH, Turbidity)

Statistical summaries of sea temperature and salinity were derived from the ODI of the Bedford Institute of Oceanography (DFO 2016) for a rectangular area surrounding the Project Area, querying the period 1900 to 2016 for depths down to 1,000 m.

Table 5.12 presents monthly depth profile statistics of mean, minimum and maximum sea temperature for the Project Area together with a count of the number of months for which there are data for the given month and depth range. Mean sea surface temperatures range from 1.8°C in February to 11.9°C in August. Minimum temperatures at the surface range from -1.8°C in February to 9.5°C in September. Maximum sea surface temperatures range from 4.6°C in March to 15.7°C in August. This seasonal temperature cycle with cooler winter temperatures and warmer temperatures in summer is observed down to 200 m. For depths greater than 200 m, sea temperature is only slightly variable by depth with monthly mean temperatures ranging from 3.3 to 4.0°C.

Table 5.12 Monthly Sea Temperature Profile Statistics

Depth (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temperature (°C)												
0	3.4	1.8	2.1	1.9	3.4	5.6	10.5	11.9	11.6	8.5	5.5	5.1
20	3.0	1.8	2.0	1.6	3.1	4.1	8.0	7.0	9.1	8.4	5.4	4.5
40	3.0	1.9	2.0	1.6	2.4	2.5	4.0	1.7	6.8	6.5	4.8	4.7
60	2.8	1.7	2.2	1.7	2.0	1.9	2.8	1.1	2.8	4.7	3.8	4.3
80	3.0	2.1	2.3	2.0	2.2	2.0	2.6	1.3	2.2	3.6	3.1	3.9
100	2.9	2.3	2.4	2.2	2.3	2.1	2.7	1.5	2.5	3.4	2.8	3.6
200	3.7	2.9	3.4	3.0	3.2	3.0	3.5	3.4	3.9	3.7	3.5	4.0
300	3.8	3.4	3.5	3.4	3.5	3.4	3.7	3.7	3.8	3.8	3.7	4.0
400	3.9	3.5	3.6	3.5	3.6	3.5	3.7	3.6	3.9	3.7	3.9	3.9
500	3.8	3.7	3.8	3.6	3.6	3.5	3.6	3.7	4.0	3.7	3.8	3.8

Depth (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
600	3.7	3.7	3.8	3.5	3.6	3.5	3.7	3.7	3.9	3.6	3.8	3.7
700	3.7	3.6	3.6	3.5	3.4	3.6	3.6	3.6	-	3.6	3.7	3.6
800	3.5	3.5	3.6	3.5	3.5	3.5	3.6	3.6	-	3.5	3.6	3.5
900	3.5	3.3	3.3	3.5	3.4	3.4	3.5	3.5	3.7	3.5	3.6	3.4
1000	3.4	-	3.3	3.3	3.4	3.4	3.4	3.5	-	3.4	3.5	3.4
Minimum Temperature (°C)												
0	-0.4	-1.8	-0.9	-1.5	-0.9	0.9	4.0	7.6	9.5	2.8	0.8	1.3
20	-0.3	-1.7	-0.9	-1.6	-1.1	-0.2	2.3	2.5	3.5	1.4	1.2	1.0
40	-0.3	-1.6	-0.8	-1.7	-1.1	-1.6	-1.4	-1.5	3.4	-0.1	0.3	0.3
60	-0.1	-1.6	-0.9	-1.6	-1.7	-1.6	-1.7	-1.5	-0.8	-0.4	-1.0	0.4
80	0.5	-1.6	-0.9	-1.5	-1.6	-1.5	-1.5	-1.5	-1.1	-0.2	-0.9	0.2
100	0.7	-1.6	-0.8	-1.4	-1.1	-1.1	-1.1	-1.2	-0.4	1.2	-0.7	-0.2
200	1.6	-0.1	2.2	-0.2	0.7	0.4	0.1	0.0	3.4	2.3	1.3	2.0
300	2.8	1.7	2.3	1.4	2.0	1.6	1.8	1.8	3.5	2.8	2.4	2.8
400	3.5	2.5	2.6	2.6	2.8	2.0	2.7	2.4	3.8	3.4	2.9	3.4
500	3.5	2.7	3.6	3.2	3.1	3.1	3.0	3.0	4.0	3.4	3.2	3.3
600	3.5	3.5	3.4	3.1	3.3	3.2	3.1	3.1	3.8	3.3	3.2	3.2
700	3.4	3.4	3.2	3.2	3.2	3.5	3.2	3.2	-	3.3	3.4	3.1
800	3.4	3.3	3.3	3.3	3.3	3.1	3.2	3.3	-	3.3	3.3	3.2
900	3.3	3.3	3.0	3.3	3.3	3.1	3.2	3.3	3.7	3.3	3.5	3.2
1000	3.4	-	3.0	3.1	3.2	3.3	3.2	3.3	-	3.3	3.3	3.1
Maximum Temperature (°C)												
0	6.5	5.8	4.6	8.6	7.5	11.6	15.1	15.7	14.3	11.8	9.9	10.8
20	6.4	5.8	4.6	9.8	6.8	9.0	13.1	14.0	14.1	11.3	10.0	8.4
40	6.4	5.1	4.6	7.8	5.6	6.6	9.3	11.7	10.9	9.8	9.9	8.5
60	6.5	5.8	4.6	7.8	5.6	6.8	7.3	6.6	6.1	9.5	9.9	8.0
80	6.1	5.8	4.6	5.0	6.0	6.7	6.5	5.7	3.8	7.6	8.2	6.2
100	4.7	5.7	4.3	4.8	4.4	6.2	6.8	5.3	3.2	6.3	7.1	6.3
200	5.1	4.7	4.7	5.1	4.8	4.8	5.1	5.6	4.4	5.6	4.9	5.4
300	4.3	4.8	4.6	4.7	4.3	4.4	4.9	4.9	4.3	5.0	4.8	4.9
400	4.7	4.6	4.5	4.2	4.2	4.3	4.7	4.4	4.1	4.5	4.7	4.4
500	4.3	4.3	4.3	4.2	3.9	4.0	4.6	4.2	4.0	4.1	4.6	4.5
600	4.3	4.0	4.3	4.1	3.8	3.9	4.3	4.1	4.0	4.0	4.6	4.6
700	4.1	3.9	4.1	3.9	3.6	3.9	4.2	4.1	-	3.9	4.0	4.0
800	3.7	3.8	3.9	3.8	3.6	3.6	4.1	3.9	-	3.8	3.9	3.9
900	3.6	3.3	3.6	3.7	3.6	3.7	4.0	3.8	3.7	3.7	3.8	3.8
1000	3.5	-	3.7	3.5	3.5	3.5	3.8	3.7	-	3.7	3.6	3.8
Number of Data Months												
0	76	57	47	211	131	166	292	71	16	46	139	71
20	55	49	52	187	116	170	296	106	15	44	125	65
40	52	49	48	194	96	157	290	107	6	42	128	70
60	55	45	47	188	95	157	287	92	13	45	127	72
80	58	45	49	197	116	167	281	96	15	45	136	76
100	55	50	38	194	98	161	279	95	13	43	136	75
200	48	45	30	141	87	153	249	57	9	39	111	62
300	46	27	23	84	75	136	199	50	7	35	99	58
400	34	28	12	42	47	84	115	32	3	31	67	45
500	28	21	9	36	22	46	101	29	2	31	39	40
600	19	12	7	15	22	44	54	26	2	28	26	37

Depth (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
700	15	9	7	12	4	14	30	23	-	24	9	31
800	13	8	4	10	14	15	29	21	-	23	9	26
900	12	1	5	6	2	8	22	13	1	18	5	19
1000	12	-	7	5	7	9	10	15	-	17	4	16

As a companion to the above sea temperature data, Table 5.13 presents monthly depth profile statistics of mean, minimum and maximum salinity for the Project Area. Sea surface salinities range from a minimum of 31.0 in July to a maximum of 34.7 in April with monthly averages that range by approximately 1, from 33.0 in July to 33.9 in February. For depths below 200 m, the variability in salinity is even less, with mean values ranging from 34.7 to 35.2 and averaging 34.8.

These temperature and salinity statistics represent the normal conditions across the Project Area. Local seawater properties will exhibit some spatial (both across the Project Area and by depth) and temporal variability. In addition, as reflected by the number of data months reported in Table 5.13, not all months or depths are well-sampled. For example, while there are 10,397 data months for depths 0 to 500 m, there are just 856 data months over the entire year for depths below 500 m.

Table 5.13 Monthly Salinity Profile Statistics

Depth (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Salinity (psu)												
0	33.9	33.7	33.9	33.6	33.7	33.3	33.0	32.6	32.5	33.6	33.5	33.7
20	33.9	33.8	33.9	33.7	33.7	33.4	33.3	33.0	33.0	33.6	33.6	33.8
40	34.0	33.9	34.0	33.8	33.9	33.7	33.7	33.5	33.7	33.8	33.7	33.9
60	34.1	34.0	34.1	33.9	34.0	33.9	33.9	33.8	34.0	34.1	33.9	34.0
80	34.2	34.0	34.2	34.1	34.1	34.0	34.1	34.0	34.2	34.3	34.1	34.2
100	34.3	34.1	34.2	34.2	34.2	34.2	34.3	34.1	34.3	34.5	34.3	34.4
200	34.7	34.6	34.6	34.6	34.6	34.6	34.7	34.6	34.8	34.8	34.7	34.7
300	34.8	34.7	34.7	34.7	34.8	34.7	34.8	34.8	34.8	34.8	34.8	34.8
400	34.8	34.7	34.7	34.8	34.8	34.8	34.8	34.8	34.9	34.8	34.8	34.8
500	34.9	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.9	34.8	34.8	34.8
600	34.8	34.9	34.8	34.8	34.9	34.8	34.9	34.9	34.9	34.9	34.8	34.8
700	34.8	34.9	34.9	34.9	34.9	34.9	34.9	34.9	-	34.9	34.8	34.8
800	34.8	34.9	34.8	34.9	34.9	34.9	34.9	34.9	-	34.9	34.9	34.8
900	34.8	34.9	34.9	34.9	35.2	34.9	34.9	34.9	34.9	34.9	34.9	34.8
1000	34.8	-	34.9	34.9	34.9	34.9	34.9	34.9	-	34.9	34.9	34.9
Minimum Salinity (psu)												
0	32.4	33.0	32.8	32.1	32.6	32.3	31.0	31.3	31.5	32.7	32.4	32.5
20	33.2	33.0	32.9	32.3	32.6	32.4	31.9	32.0	32.2	32.8	32.6	32.7
40	33.3	33.1	33.2	32.9	32.8	32.7	32.4	32.8	33.5	33.1	32.9	33.0
60	33.3	33.1	33.2	33.0	32.9	33.0	32.8	33.0	33.1	33.2	33.3	33.3
80	33.4	33.1	33.4	33.2	33.1	33.0	33.0	33.1	33.3	33.7	33.4	33.5
100	33.8	33.2	33.5	33.3	33.3	33.1	33.3	33.3	33.6	33.7	33.4	33.7
200	34.2	33.8	34.3	33.5	34.1	34.0	34.1	34.0	34.7	34.4	34.2	34.3
300	34.5	34.3	34.4	34.3	34.4	34.2	34.3	34.4	34.8	34.5	34.5	34.6
400	34.7	34.4	34.5	34.6	34.7	34.5	34.6	34.6	34.8	34.7	34.6	34.7
500	34.8	34.5	34.6	34.7	34.7	34.8	34.7	34.7	34.9	34.7	34.6	34.8
600	34.8	34.8	34.6	34.8	34.8	34.8	34.7	34.7	34.9	34.7	34.7	34.8
700	34.6	34.8	34.8	34.8	34.9	34.8	34.8	34.8	-	34.9	34.8	34.8

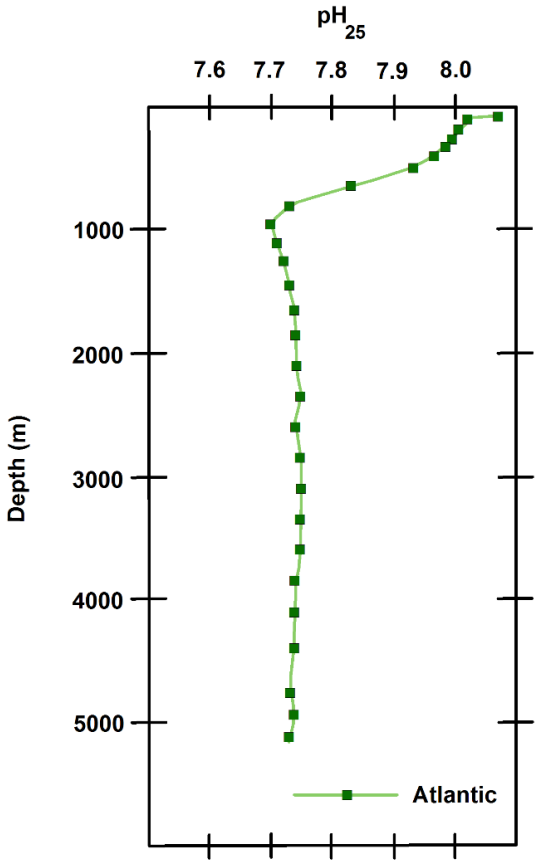
Depth (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
800	34.8	34.9	34.6	34.9	34.8	34.8	34.8	34.7	-	34.8	34.8	34.8
900	34.8	34.9	34.8	34.9	34.9	34.8	34.8	34.9	34.9	34.9	34.9	34.8
1000	34.8	-	34.8	34.9	34.8	34.9	34.9	34.9	-	34.7	34.8	34.8
Maximum Salinity (psu)												
0	34.6	34.2	34.6	34.7	34.6	34.3	34.4	34.1	33.3	34.3	34.4	34.3
20	34.6	34.5	34.7	34.7	34.8	34.4	34.5	34.2	33.8	34.3	34.4	34.3
40	34.6	34.8	34.6	34.7	34.4	34.5	34.6	34.7	34.0	34.3	34.4	34.4
60	34.6	34.8	34.6	34.7	34.6	34.6	34.7	34.7	34.3	34.8	34.5	34.4
80	34.6	34.8	34.6	34.7	34.6	34.7	34.7	34.7	34.5	34.9	34.7	34.7
100	34.6	34.8	34.7	34.8	34.7	34.7	34.8	34.8	34.5	34.8	34.9	34.8
200	35.0	34.9	34.9	34.9	34.9	34.8	35.1	35.1	34.9	34.9	35.0	34.9
300	34.9	34.9	35.0	35.0	34.9	34.9	35.1	34.9	34.9	34.9	34.9	34.9
400	35.1	34.9	34.9	35.0	34.9	34.9	35.1	34.9	34.9	34.9	34.9	34.9
500	35.1	35.0	35.0	35.0	34.9	34.9	35.1	34.9	34.9	34.9	34.9	34.9
600	34.9	35.0	35.0	34.9	34.9	34.9	35.1	34.9	34.9	34.9	34.9	34.9
700	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	-	34.9	34.9	34.9
800	34.9	34.9	35.0	34.9	34.9	34.9	35.0	34.9	-	34.9	34.9	34.9
900	34.9	34.9	34.9	34.9	35.6	34.9	34.9	34.9	34.9	34.9	34.9	34.9
1000	34.9	-	34.9	34.9	34.9	34.9	34.9	34.9	-	34.9	34.9	34.9
Data Months												
0	76	57	47	211	131	166	292	71	16	46	139	71
20	55	49	52	187	116	170	296	106	15	44	125	65
40	52	49	48	194	96	157	290	107	6	42	128	70
60	55	45	47	188	95	157	287	92	13	45	127	72
80	58	45	49	197	116	167	281	96	15	45	136	76
100	55	50	38	194	98	161	279	95	13	43	136	75
200	48	45	30	141	87	153	249	57	9	39	111	62
300	46	27	23	84	75	136	199	50	7	35	99	58
400	34	28	12	42	47	84	115	32	3	31	67	45
500	28	21	9	36	22	46	101	29	2	31	39	40
600	19	12	7	15	22	44	54	26	2	28	26	37
700	15	9	7	12	4	14	30	23	-	24	9	31
800	13	8	4	10	14	15	29	21	-	23	9	26
900	12	1	5	6	2	8	22	13	1	18	5	19
1000	12	-	7	5	7	9	10	15	-	17	4	16

As pH data for the Project Area are scarce and limited in both temporal and spatial resolution, the description provided herein is based on data collected from the World Ocean Circulation Experiment (WOCE) database for the entirety of the Atlantic Ocean (data available at http://cdiac.ornl.gov/oceans/CDIACmap.html). Figure 5.28 shows that surface waters in the Atlantic Ocean have a pH (adjusted to 25°C temperature) range of 8.0 to 8.1, which decreases to approximately 7.7 at 1,000 m depth, then remaining stable to the ocean floor. An example CTD profile of surface waters (0-80 m) from the Hibernia Environmental Effects Monitoring (EEM) Program in 2015 is shown in Figure 5.29, which agrees with surface waters on the Grand Banks having a pH of approximately 8.1.

Turbidity data are similarly scarce for the Project Area. Data are available from the National Oceanic and Atmospheric Administration (NOAA), from a cruise in March of 2011 in an area north of Flemish Pass (Ullman et al 2013). From this cruise, it can be seen that turbidity is approximately 0.2 to 0.3 NTU

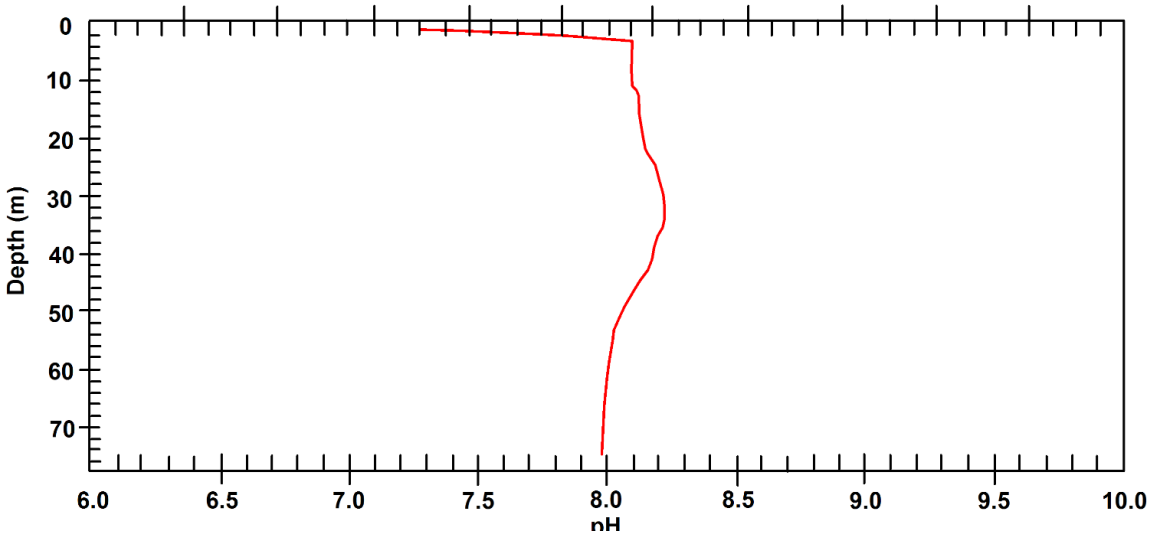
in near-surface waters and steadily decreases to below 0.01 at 200 m and deeper. It should be noted that there is some potential for seasonal variability associated with biogenic fallout.

Figure 5.28 Overview of pH for the Atlantic Ocean from the WOCE



Source: Wallace (1997)

Figure 5.29 Surface pH Data from Hibernia EEM Program (December 9, 2015)



Source: Stantec Consulting (2014)

5.5.5 Tides

Water level variations due to tides in the Project Area are generally quite predictable. Several models are available for the prediction of water levels at specific locations where the tidal constituents are known or can be extrapolated from other locations.

Using the WebTide model (Dupont et al 2002), based on tidal modeling studies conducted by DFO, tidal water levels are computed for the Project Area at the same location of the referenced MSC50 node (used for wind and wave analysis) and are shown in Table 5.14.

The contribution of each tidal constituent to the observed tidal range during a full tidal cycle is twice its amplitude. The largest contribution comes from M2, the principal lunar semidiurnal constituent, followed by K1, the luni-solar diurnal constituent and S2, the principal solar semidiurnal constituent. The other components have a smaller contribution toward the observed tides. Overall, the water levels exhibit two high tides and two low tides per day, with one set of tides having a higher tidal range than the other.

Table 5.14 Tidal Predictions

Location	Tidal Constituent	Constituent Amplitude (cm)	Phase (deg GMT)	Total Amplitude (cm)
(47.5°N, 46.5°W)	M_2	14.8	327.9	39.6
	K_1	8.1	160.0	
	N_2	3.0	312.5	
	S_2	7.7	3.7	
	O_1	6.0	132.0	

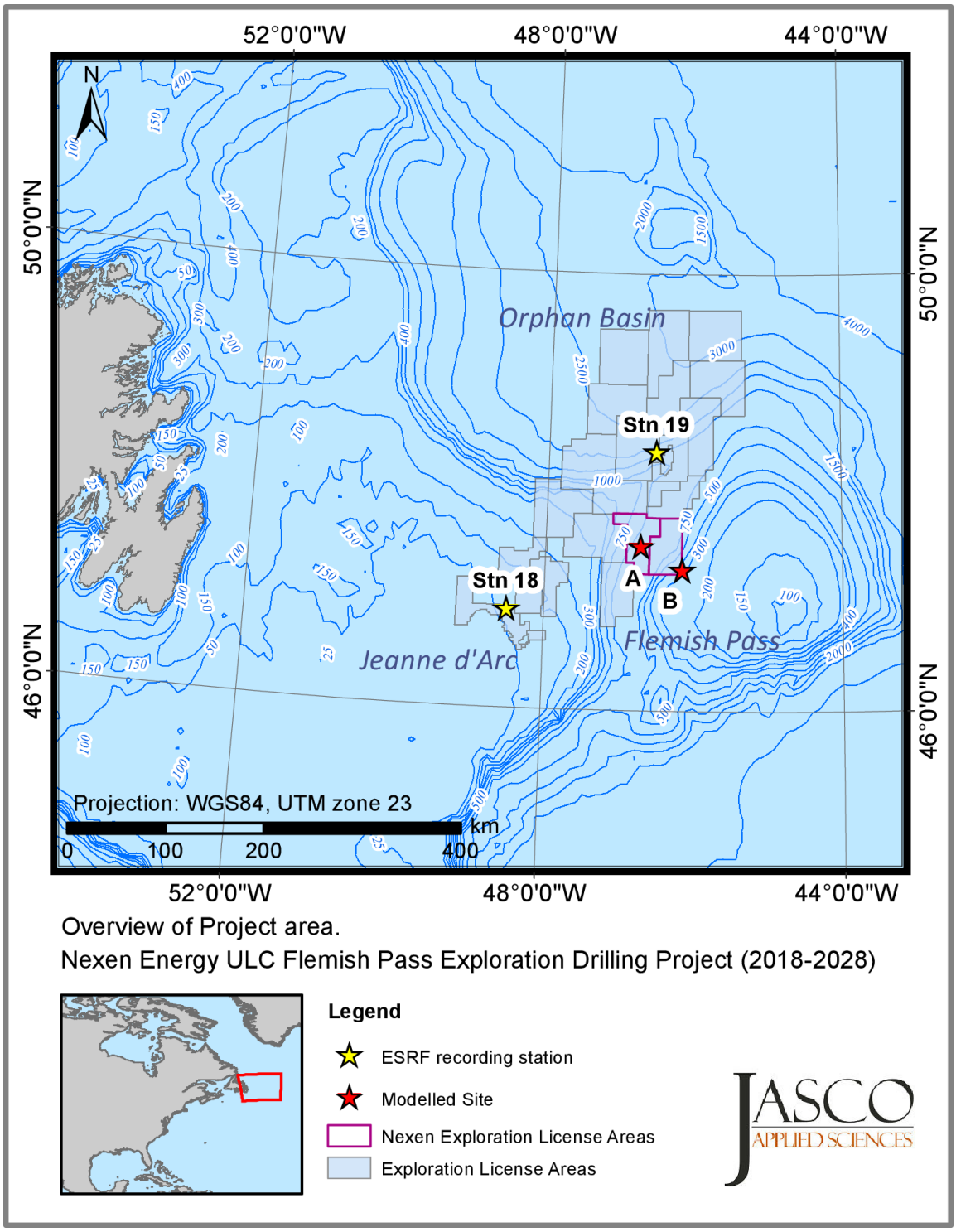
5.5.6 Storm Surge

Storm surge is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. Storm surge amplitudes can be particularly high in coastal areas, but surges with comparatively smaller amplitudes can also occur offshore, away from the coastline. A hazard from storm surges is elevated mean water levels, particularly when they occur at high tide. A study by Bernier and Thompson (2006), which used a hindcast of water levels over 40 years, calculated a potential storm surge of 70 cm in the Northwest Atlantic. The Bernier and Thompson model agrees well with observations recorded by Seaconsult (1998), which indicated that the expected storm surge levels range between 50 cm (1 year return period) and 73 cm (100 year return period).

5.5.7 Underwater Ambient Noise

The existing noise environment or sound-scape of the Project Area and RSA is characterized by a degree of existing underwater noise, resulting from natural conditions and processes, such as weather and wave action, marine mammals, as well as from other human activities that occur in parts of the region on either a continuous basis (i.e., existing petroleum production platforms in the Jeanne d'Arc Basin) or those which are more intermittent and transient in nature, such as fishing activity, other oil and exploration programs, and marine transportation.

Figure 5.30 Overview of the Project Area, Modelled Sites and Ambient Level Recording Stations



As part of its analysis of underwater sound generation and its potential effects for this EIS, Nexen commissioned JASCO to complete a desk-top study of existing underwater sound levels, as well as an analysis of potential sound types and levels that may be generated by planned Project activities and their possible propagation. This report is provided as Appendix E of this EIS, with its results used in the

applicable environmental effects assessments. The results of the ambient underwater noise analysis are summarized briefly below, with details (including the associated graphs referred to in the summary below) provided in Appendix E.

In July 2016, JASCO deployed 20 acoustic recorders along Canada's east coast for the second year of a two-year baseline monitoring program sponsored by the ESRF. The recorders were retrieved in July 2017. Data from two of these recorders are discussed here, as they provide the best available information on the existing sound levels in the Project Area (Figure 5.30). ESRF Station 18 was in shallow water at a depth of 214 m, 28 km from the Hibernia platform in the existing Jeanne D'Arc Basin area. ESRF Station 19 was in deep water (over 1,500 m) in the Flemish Pass. The locations of both stations are illustrated in Figure 5.30.

Ambient noise levels at the two recording stations were examined to document the local baseline underwater sound conditions. Monthly distributions provide an overview of the range of sound levels and how they change by season. To describe the general characteristics of the soundscape, ambient noise levels for four months throughout the year are presented as follows. Please note that for efficiency purposes, the detailed data graphs referenced below (from the JASCO 2017 report, see EIS Appendix E) have not been reproduced here, and so the appended report itself should be consulted for these details.

- Broadband and approximate-decade-band sound pressure level (SPL) over time for these frequency bands: 10 Hz to 4 kHz, 10–100 Hz, 100 Hz to 1 kHz, and 1–4 kHz. The associated graphs (See Appendix E) provide an overview of the time and frequency variations in the soundscape.

- Spectrograms: Ambient noise at each station was analyzed by Hamming-windowed fast Fourier transforms (FFTs), with 1 Hz resolution and 50 percent window overlap. The 120 FFTs performed with these settings are averaged to yield 1 min average spectra. These plots are presented with the SPL band plots and provide more detailed temporal and spectral distribution information that helps in identifying the various noise contributors (e.g., marine mammals, and natural and geologic sources).

- Box-and-whisker plots of the statistical distribution of SPL in each 1/3 octave frequency band. The boxes of the statistical distributions indicate the first (L25), second (L50), and third (L75) quartiles. The whiskers (vertical lines) indicate the maximum and minimum range of the data. The solid line indicates the mean SPL, or Lmean, in each 1/3 octave frequency band. These plots are presented with the spectral density level percentile plots.

- Spectral density level percentiles: Histograms of each frequency bin per 1 min of data. The Leq, L5, L25, L50, L75, and L95 percentiles are plotted. The L5 percentile curve is the frequency-dependent level exceeded by 5 percent of the 1 min averages. Equivalently, 95 percent of the 1 min spectral levels are above the 95th percentile curve. Theses curves (Appendix E, Section 4.3.2), together with the statistical distribution plots, provide information about the distribution of sound levels in each frequency band over a full month.

- Daily sound exposure levels (SEL): Computed for the total received sound energy and the detected shipping energy. The SEL is the linear sum of the 1 min SEL. For shipping, the 1 min

SEL values are the linear 1 min squared SPL values multiplied by the duration, 60 s. For seismic survey pulses, the 1 min SEL is the linear sum of the per-pulse SEL. Although not frequency-filtered, these daily levels use the same sound metric as the injury criteria assessed in this report.

5.5.7.1 Ambient Sound Pressure Level versus Time

Long-term spectral averages along with median band-level time series figures (see Appendix E, Figures 21–25) provide an overview of the time and frequency variations in the soundscape. Specifically, Figure 21 presents the long-term spectrogram for the entire ESRF deployment running from July 2016 to July 2017.

Station 18 noise levels remained fairly constant throughout the year, with the exception of an increase in noise levels in the 100–1000 Hz and 1–4 kHz bands in winter. This increase is attributed to wind-driven bubble and spray noise. The soundscape at Station 19 was strongly affected by seismic surveys in summer and fall, but mooring strum noise kept broadband noise levels high throughout the year.

To represent the yearly temporal variations, Appendix E Figures 22–26 show the SPL over February (2017), May (2017), August (2016), and November (2016). In February and May, the soundscape was influenced by vessel noise, particularly at Station 18, and flow noise around 25 Hz at Station 19. In August, the soundscape was dominated by seismic activity, but vessels continued to be important noise contributors at Station 18. Fin whale songs in the band of 18–25 Hz were detectable beginning in August, and were a dominant sound source from October through March at both stations.

5.5.7.2 Spectral Levels and 1/3-Octave Band Levels

Power spectral density and 1/3 octave band distribution plots (see Appendix E, Figures 26–29) can be directly compared to the Wenz plots (see Appendix E, Figure 5) and provide more detailed spectral distribution information than the long-term spectral averages and box-and-whisker plots. The contribution of fin whale song notes at 20 and 130 Hz can be seen starting in August, peaking in November, and continuing until March. At Station 19, sound levels at 20–25 Hz were strongly influenced by flow noise, particularly in February and May. Seismic activity and shipping noise near Station 19 contributed to sound levels across a broad range of frequencies, raising the power spectrum levels by nearly 20 dB below 300 Hz. Note that the power spectral density levels were consistent across the band between months at Station 18, reflecting the steady activity and vessel traffic near the Hibernia platform.

5.5.7.3 Daily Sound Exposure from Anthropogenic Sources

The daily SEL (see Appendix E, Figures 30–33) integrates the total sound energy over 24 hours at a receiver location. SEL is one of the metrics used to define the thresholds for the onset of temporary and permanent threshold shifts (NMFS 2016).The presented ambient daily SEL are not, however, frequency-weighted.

Vessel activity was a primary noise contributor throughout the year, particularly at Station 18. Noise associated with seismic activity was not detected at either station in February. Among the four analyzed months, noise from seismic activities was only present at Station 19 in August, when it was the main contributor to the daily SEL. The contribution of anthropogenic sources decreased in November at Station 19, with peaks in daily SEL associated with current-induced mooring flow noise. Daily SEL were

very consistent across months at Station 18, once again reflecting the steady ongoing activity at Hibernia. In contrast, SEL were lowest during winter at Station 19, when noise from shipping and seismic activity were at a minimum (See Appendix E, Figures 30-33).

5.6 Ice Conditions

Portions of the Project Area are subject to seasonal intrusions of sea ice and icebergs, as well as vessel icing during particular wind, wave and air temperature conditions. Sea ice and iceberg conditions vary each year and by location, and are influenced by colder or milder winter conditions over Newfoundland and the surrounding waters, and seasonal wind patterns. Cold and dry winds from the west through north have the effect of moving ice further offshore, while northeasterly winds tend to bring ice towards shore. Any of these factors may influence the distribution of ice over the Project Area.

5.6.1 Sea Ice

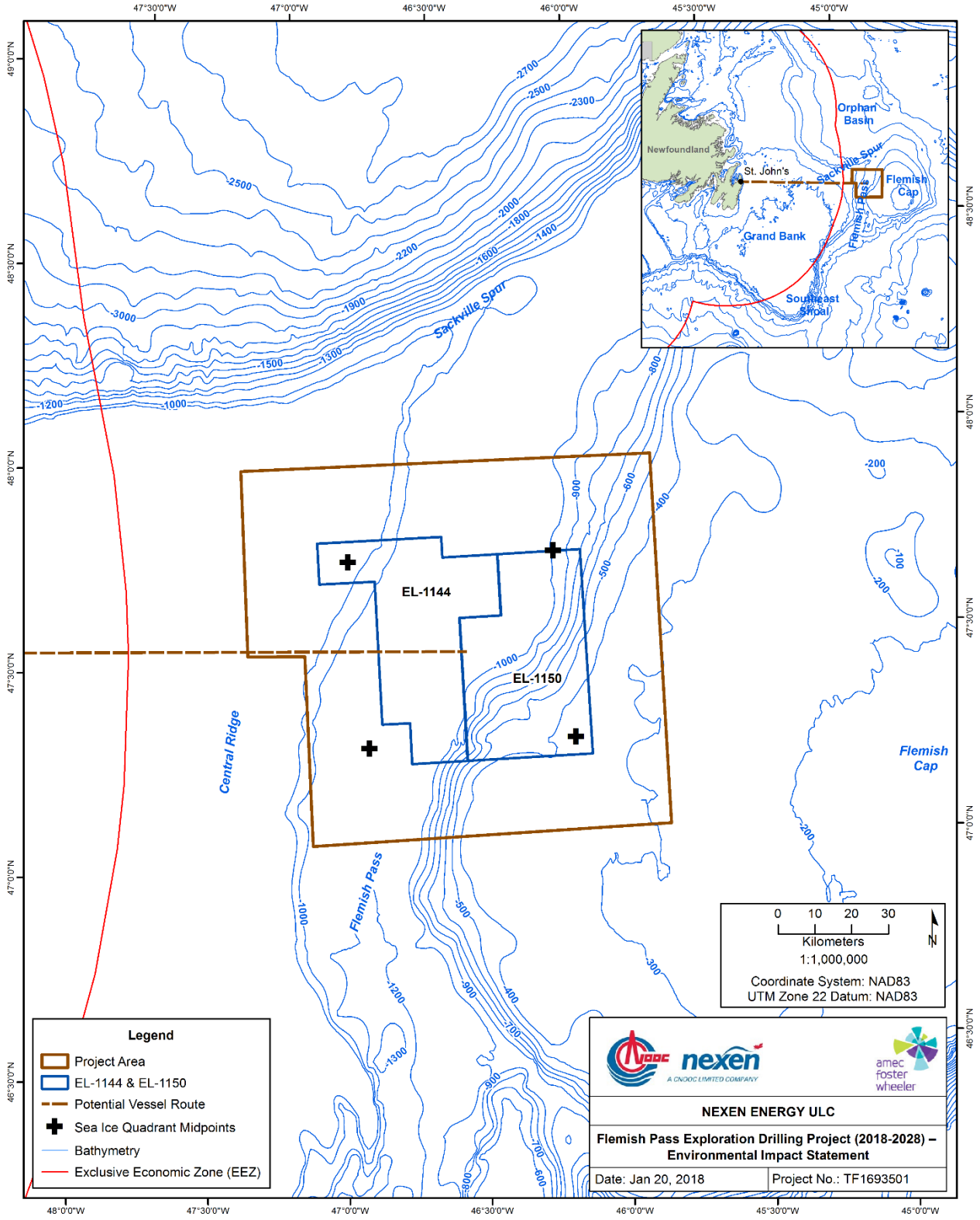
This section provides an overview of the sea (drift or pack) ice conditions most likely to be encountered in the Project Area. Information is drawn from the CIS Sea Ice Climatic Atlas for the East Coast 1981-2010 (CIS 2011) which reports how frequently sea ice is present, its concentration when present, and its predominant ice type and hence thickness. Given that the CIS Regional Ice Charts are not always prepared on the same dates each year, a seven-day period centered on historical dates is used in the atlas. The atlas climate data represent information from charts within three days on either side of the historical date. For example, the chart for historical date 15 January is representative for the period 12 to 18 January.

As noted in the Ice Atlas, variations in the extent of ice over Eastern Newfoundland waters, and hence the Project Area, are great due to both winds and temperatures being effective in changing the location of the ice edge. A large variability in sea ice conditions can therefore be experienced from year to year, and within any given year, on time scales of days to weeks and over comparatively small geographic scales of tens of kilometres. There is potential for landfast ice (ice which forms and remains fast along the coast) nearshore and can extend from a few metres to several hundred kilometres offshore). This may pose a consideration for the potential vessel and aircraft transit route near the coastline of Eastern Newfoundland; however, it is unlikely to be a factor in the Project Area itself.

Sea ice may be present throughout the Project Area with the influx of ice that drifts south from Labrador and the northeast coast of Newfoundland and out onto the Grand Banks and east over the Orphan Basin and Flemish Pass. For this part of the Northwest Atlantic Ocean, for a given week during the ice season, the sea ice is generally more likely of greater concentration and thickness in the western portions and less severe further offshore to the east. With passing weeks, as the ice advances, there is potential that thicker sea ice to the west and north will continue to drift farther offshore (south and east).

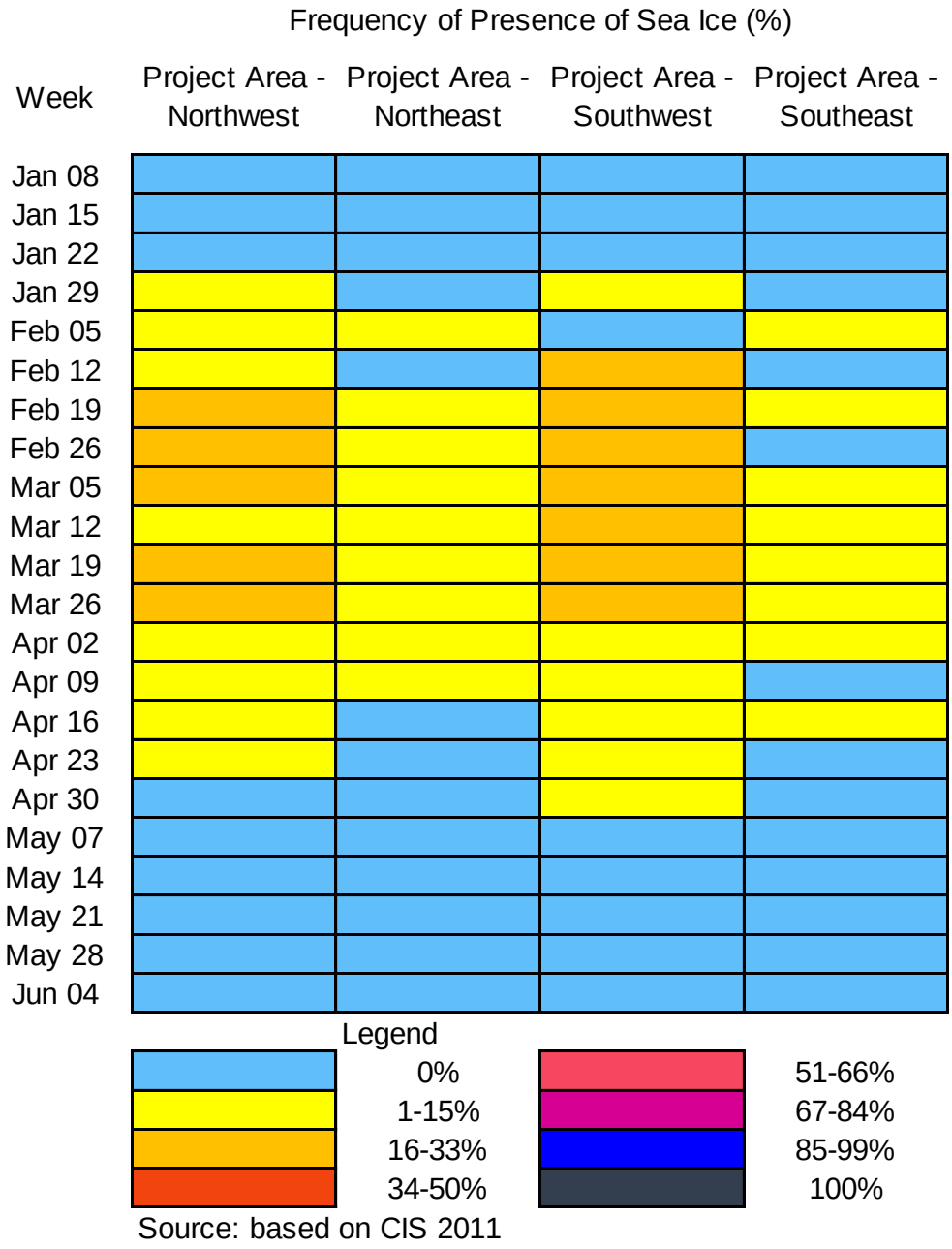
To characterize overall conditions, the sea ice is tabulated for four representative “quadrants” over the Project Area. An approximate midpoint of each quadrant was selected (as illustrated in Figure 5.31), which was overlain on each of the weekly atlas charts. The corresponding frequency of ice presence, ice concentration and ice type were noted for all weeks at each of the quadrants. The resulting tabulations are presented in Tables 5.15 to 5.17, with values colour-coded to show at a glance the weekly change in ice conditions for four quadrants of the Project Area: northwest, northeast, southwest and southeast.

Figure 5.31 Project Area Locations Used for Sea Ice Characterization



A general discussion of sea ice conditions over the Project Area is presented following these tables. It should be emphasized that for simplicity these tables report just one value for each of the four quadrants whereas conditions may vary considerably within a given quadrant. While some of the variation in conditions near these quadrant midpoints is discussed below, for a higher resolution analysis the atlas (CIS 2011) should be consulted. It is further noted that conditions reported here are from climatology and each year will be different.

Table 5.15 Frequency of Presence of Sea Ice (%)



Source: based on CIS 2011

Table 5.16 Median of Ice Concentration, When Ice is Present

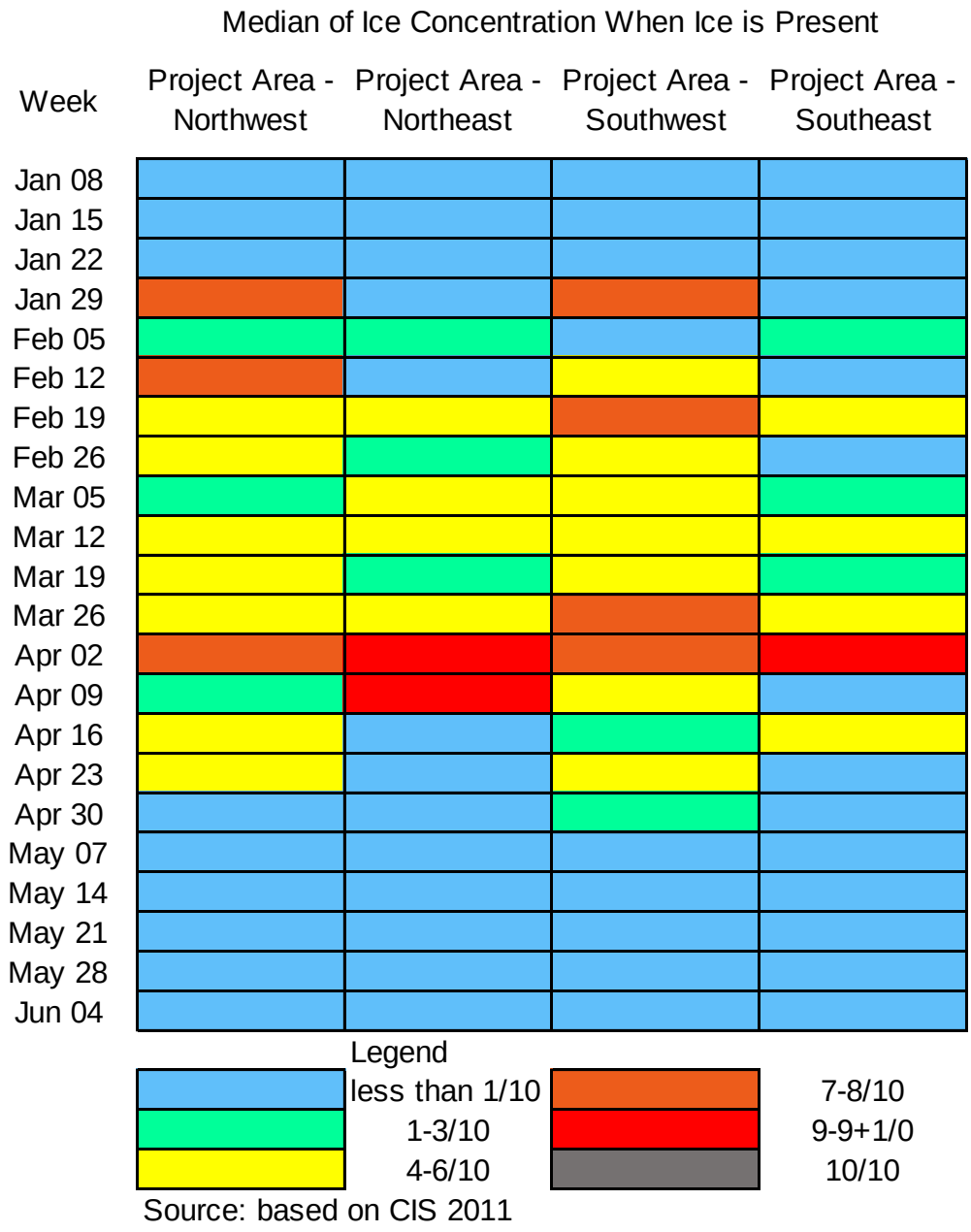
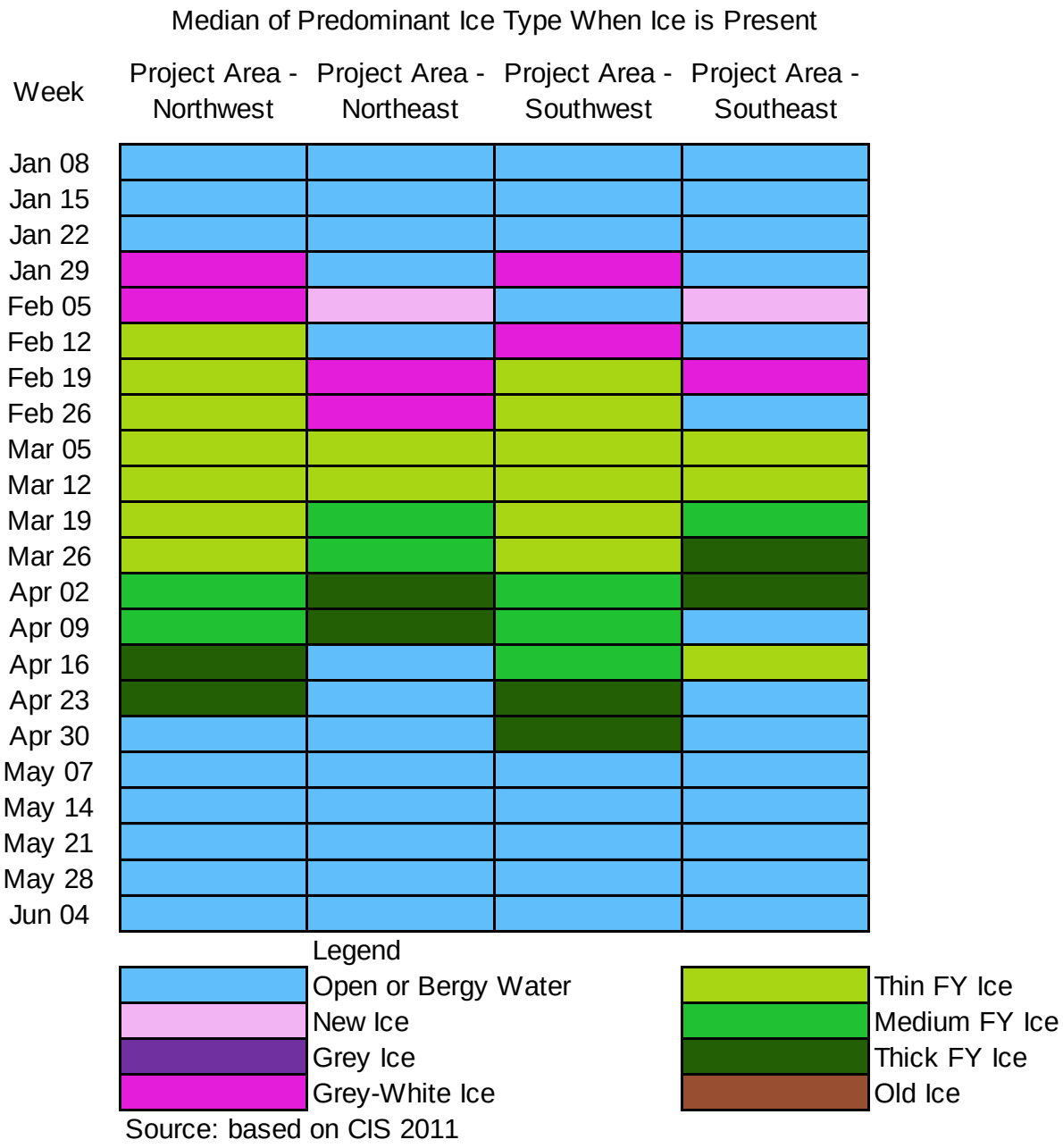


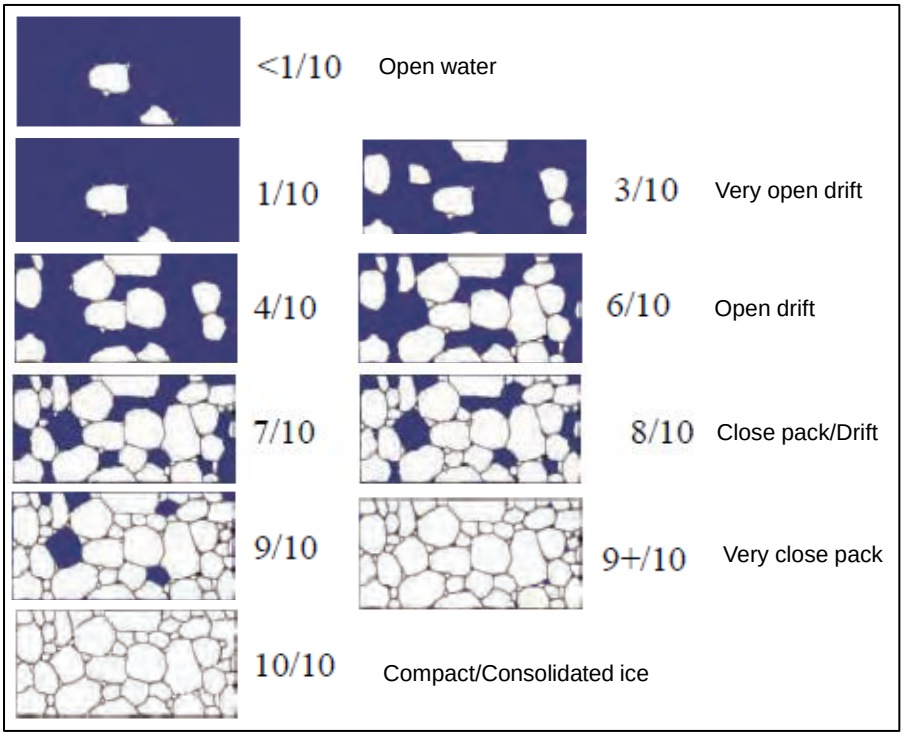
Table 5.17 Median of Predominant Ice Type, When Ice is Present



Source: based on CIS 2011

To accompany the Tables above, Figure 5.32 (derived from the MANICE publication, CIS 2005) illustrates the scale in which ice concentration is reported, from open water (ice concentration of less than 1/10) to compact/consolidated ice (10/10 concentration). Table 5.18 from MANICE (CIS 2005) illustrates the stages of sea ice development that occur together with their associated thickness.

Figure 5.32 Ice Concentrations from an Aerial Perspective



Source: CIS (2005)

Table 5.18 Stage of Development, Sea Ice

Description	Thickness
New	<10 cm
Nilas; Ice rind	<10 cm
Young	10-30 cm
Grey	10-15 cm
Grey-white	15-30 cm
First-year	≥30 cm
Thin first-year	30-70 cm
Medium first-year	70-120 cm
Thick first-year	>120 cm
Source: CIS (2005)	

Ice is present as early as mid- to late-January for the most-western portion of the Project Area and over the entire Project Area by the week of 5 February and as late as mid- to late-April. The latest ice is seen the week of 30 April over only the western portion of the Project Area. The week of 2 April is generally the time when the ice season is at its peak in terms of ice extent and presence of first year (FY) ice over the Project Area.

The frequency of presence of sea ice during January and the first week of February is at least 1 to 15 percent, or about as frequent as every six or seven years. The likelihood of ice over the western portion of the Project Area doubles to 16 to 33 percent of the time from the week of 12 February to the end of March. The central and western portions of the Project Area see a similar increased likelihood during the week of 19 March.

Beginning in mid-January, when ice is present, ice concentrations are generally 1/10 to 3/10 and with the predominant ice type being grey-white (15-30 cm thickness). By the end of January median ice concentrations are 7/10 to 8/10. In the first week of February the median sea ice concentrations range from 1/10 to 3/10 of new ice (less than 10 cm) to 4/10 to 6/10 of grey-white and grey (10-15 cm) ice. For the remainder of February the sea ice is grey-white and thin FY ice (ice of not more than one winter's growth, 30-70 cm), and during this period ice concentrations range from 1/10 to 3/10, to 7/10 to 8/10.

For the first two weeks of March, when ice is present, it is thin FY ice in concentrations mostly of 4/10 to 6/10 but with some areas to the northeast and southeast of 7/10 to 8/10. Similar concentrations are likely for the remainder of March though over the eastern portions of the Project Area, medium FY ice (70-120 cm) might be expected for the week of 19 March and thick FY ice (greater than 120 cm) might be expected for the week of 26 March.

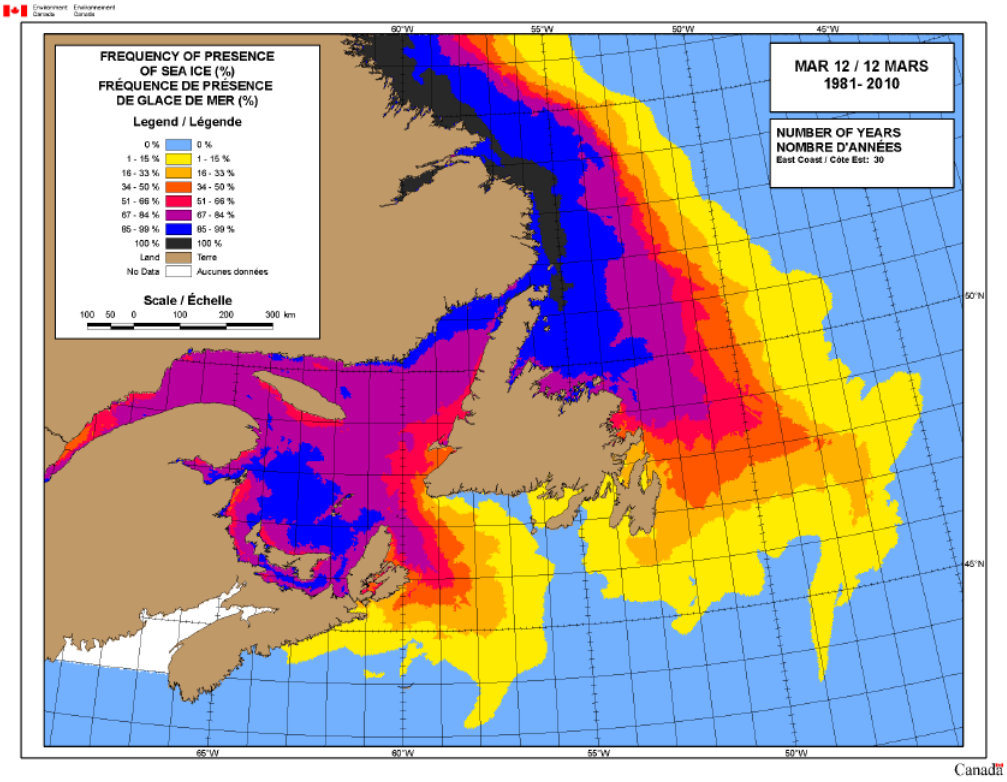
The first week of April is likely the most severe time for sea ice over the Project Area. Ice concentrations are mostly 9/10 to 9+/10 with patches of 7/10 to 8/10 to the west. The ice is predominantly thick FY with medium FY ice over the western quarter of the Project Area. Both medium FY ice (to the west) and thick FY ice (to the north, east and south) persist through the week of 9 April although at lesser concentrations, mostly 1/10 to 3/10 to the west and east and 9/10 to 9+/10 to the north and south.

By the week of 16 April, the presence of sea ice is likely limited to the central and western portion of the Project Area and consists of thin, medium and thick FY ice (30 cm to greater than 120 cm) in concentrations generally of 4/10 to 6/10. By the last two weeks of April, when ice is present, the median concentration is 4/10 to 6/10 or less and of type thick FY. By May the Project Area is normally ice free.

The potential for encountering sea ice while transiting existing and potential vessel transit routes between St. John's and the Project Area exists from January to May (Figures 5.33 to 5.35). The greatest frequency of occurrence of sea ice is likely between February and early April at approximately 16 to 33 percent (or every three to six years) with some areas during the week of 12 March indicating a 34 to 50 percent likelihood. The greatest risks are likely encountering areas of high ice concentration of 9 to 9+/10 in late February and March and medium and thick first year ice (≥70 cm) from the end of March through the beginning of May.

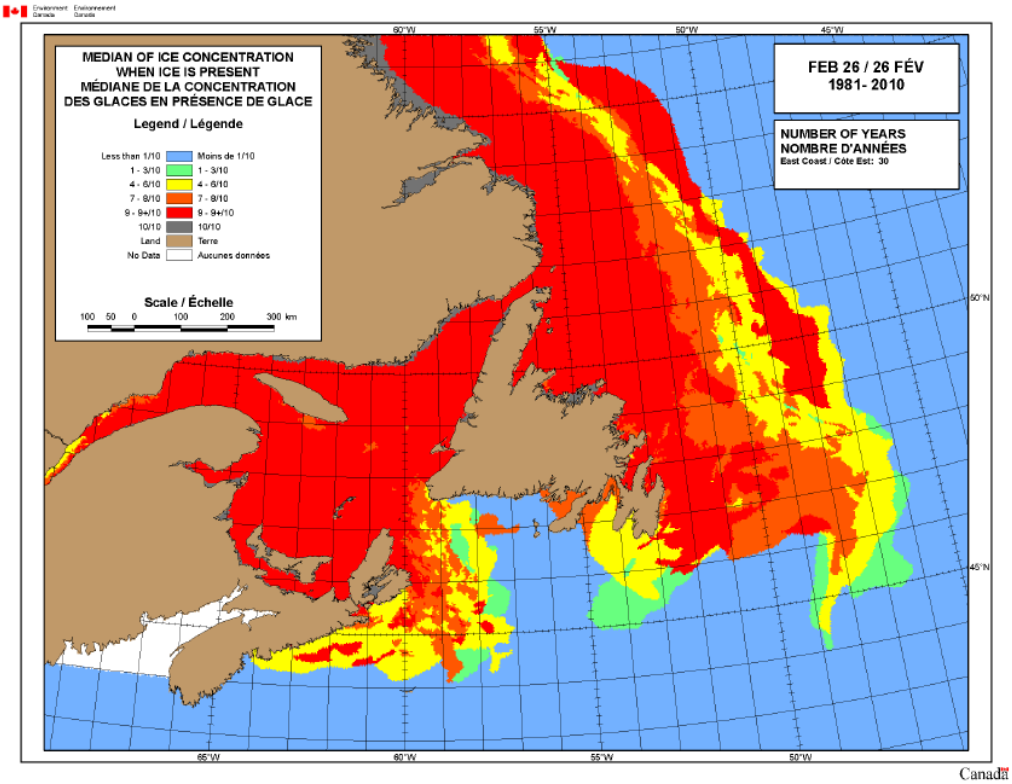
Further information on regional ice conditions in this area is provided in the Eastern Newfoundland SEA (Amec 2014), Section 4.1.5.

Figure 5.33 Frequency of Presence of Sea Ice, Week of Mar 12



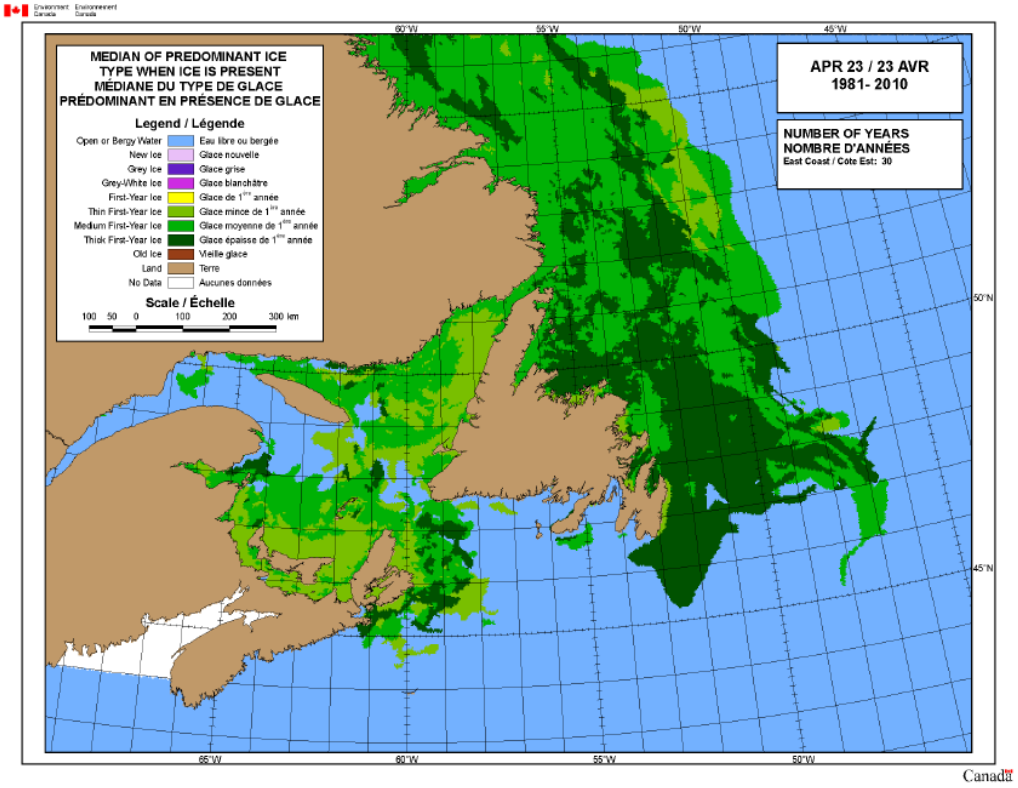
Source: CIS (2011)

Figure 5.34 Median of Ice Concentration When Ice Is Present, Week of Feb 26



Source: CIS (2011)

Figure 5.35 Median of Predominant Ice Type When Ice Is Present, Week of Apr 23



Source: CIS (2011)

5.6.2 Icebergs

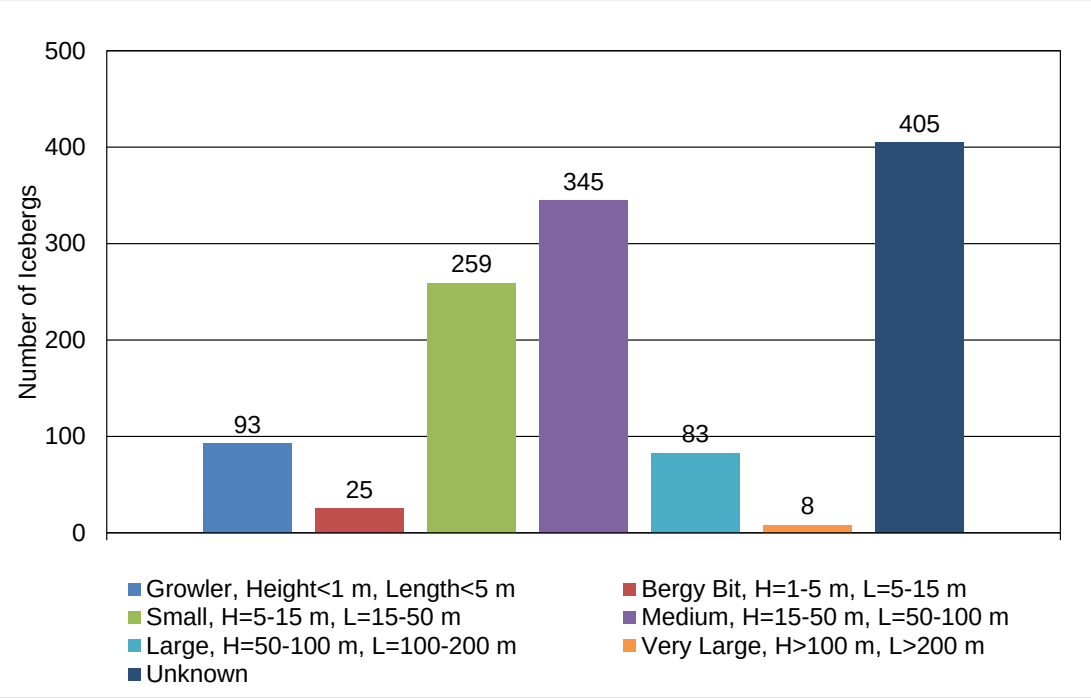
The summary of iceberg sightings for the Project Area presented here is based primarily on the comprehensive NRC-PERD Iceberg Sighting Database (Sudom et al 2014; NRC 2015). The iceberg sightings are from various sources including industry, aircraft and ship, and include radar, visual and measured observations. Statistics are reported here for first iceberg sightings (excluding any re-sightings of the same iceberg), and include size classes ranging from growlers (less than one m in height, less than five m in length and mass about 500 t) to very large icebergs (greater than 100 m in height, greater than 200 m in length, and mass over five Mtonnes). Icebergs of unknown size are also reported.

To provide a characterization of iceberg conditions for the Project Area a rectangular area that contains the Project Area (47-48°N, 45.7-47.3°W), was queried for the past 30 years (1985-2014). Three sets of summary statistics for the number of icebergs by iceberg size, month and year, are presented in Figures 5.36 to 5.38. The usual iceberg height and length associated with each size class are shown in the Figure 5.36 legend. Data from 2013 and 2015 are absent from the 2015 PERD database release; however, observations for both of these years were accessed from the International Ice Patrol (IIP) Iceberg Sightings Database (IIP 1995, updated 2016) and are discussed below. The NRC-PERD iceberg database query yielded 1,218 icebergs (first sightings) with size known for about two thirds of the observations. Of these 813 icebergs, 118 (15 percent) are growlers or bergy bits, 604 (74 percent) are small or medium, 83 (10 percent) are large, and two (1 percent) are very large (Figure 5.36).

The iceberg season generally lasts from January through August, with 85 percent of first sightings during March through June (Figure 5.37). Of the 22 January sightings, 15 were in mid- to late-January 1993 (with another six in 1985 and one in 1987) including a large, pinnacle-shaped iceberg sighted in the northwest corner of the Project Area. The 83 large icebergs sighted in the Project Area were observed in all months from January to August with 29 observed in May. The eight very large icebergs were seen in March (two icebergs) and April (six icebergs). Over the 30 year record, 1985-2014, there have been eight sightings after August in the Project Area: four in September, three in October and one in December. These eight consist of a small iceberg in September 1985 sighted in the very southwest corner of the Project Area, and seven iceberg targets from 1992, mostly located in the western portion of the Project Area. The December sighting was a bergy bit near the southern boundary of the Project Area.

As illustrated in Figure 5.38, The number of icebergs reported (first sightings) annually for the Project Area will vary and has historically ranged from zero in numerous years, including the four years from 2004 to 2007 to a maximum of 217 in 2002 and has averaged 55 icebergs. From the IIP dataset, in 2013 there were numerous icebergs (3,610 sighted in total) off the coast of Labrador, through the Strait of Belle Isle and into the Gulf of St. Lawrence and off the northeast coast of Newfoundland. There were, however, very few near the western portion of the Grand Banks and none closer than about 200 km of the western boundary of the Project Area. In 2015 there were 84 first sightings in the Project Area as shown in Figure 5.38 together with all 2015 east coast first sightings. Of the 84 sightings in the Project Area, two were very large icebergs, 11 were large, 37 were small or medium and 34 were either growlers or of unspecified size.

Figure 5.36 Iceberg Sightings by Size Category (1985-2014), Project Area

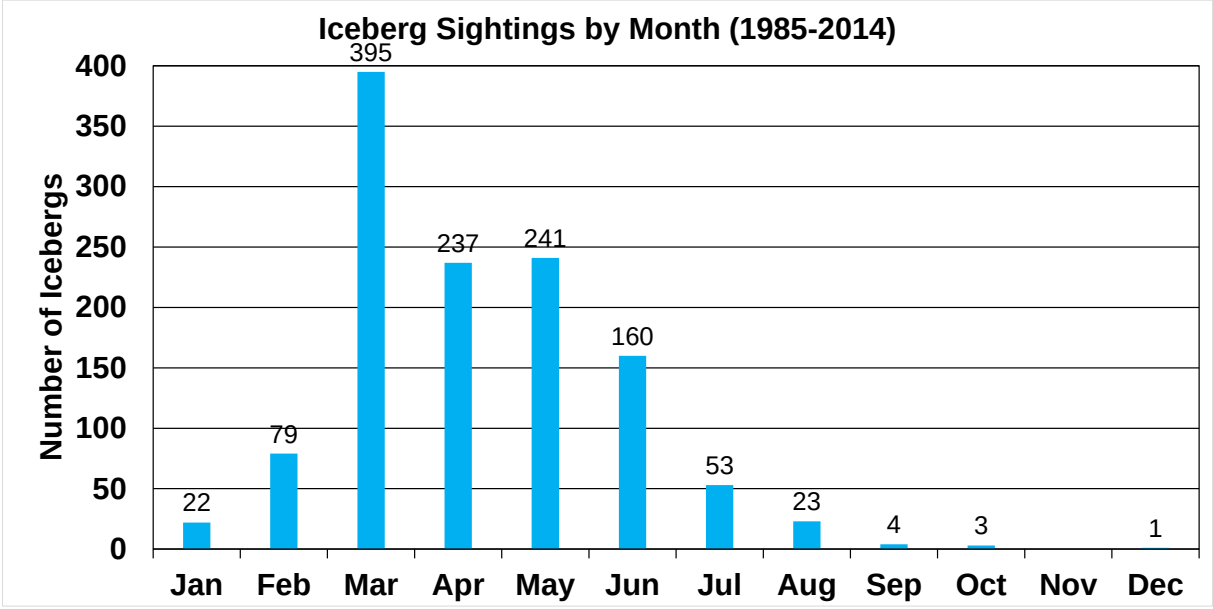


Source: NRC (2015)

As evidenced by the 2015 distribution of icebergs on the east coast shown in Figure 5.39 (first sightings are shown) the potential for encountering icebergs while transiting between Eastern Newfoundland and

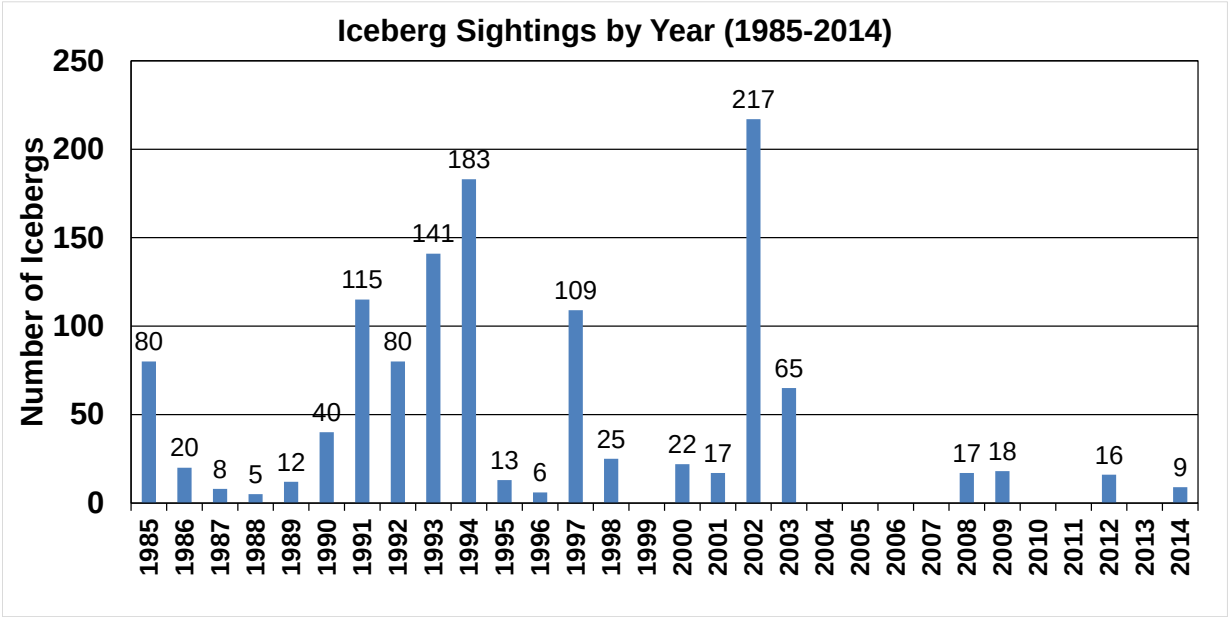
the Project Area may be high, depending on the time of year. The iceberg risk is greatest during the months of March through May although, depending on the iceberg season and location offshore, icebergs may potentially pose a moderate risk for marine traffic anytime between January and June. Daily ice charts from the CIS and supply vessel and aircraft reports of local and regional conditions will again provide the most current and directly useful information for navigation under iceberg conditions (see Section 17.1). Further information on regional ice conditions in this area is provided in the Eastern Newfoundland SEA (Amec 2014), Section 4.1.5.

Figure 5.37 Iceberg Sightings by Month (1985-2014), Project Area



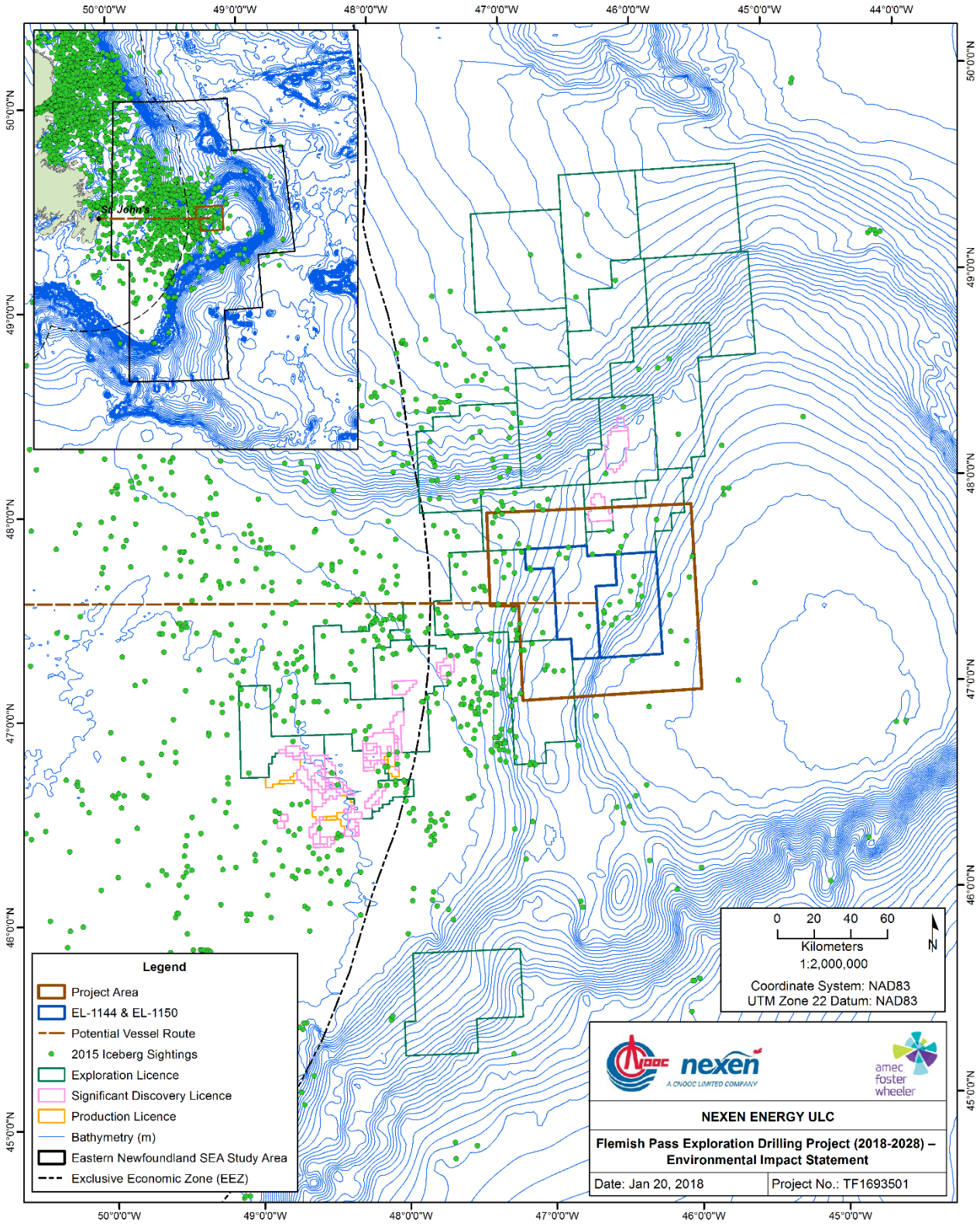
Source: NRC (2015)

Figure 5.38 Iceberg Sightings by Year (1985-2014), Project Area



Source: NRC (2015)

Figure 5.39 Recorded Icebergs Sightings in 2015, Offshore Eastern Newfoundland



Source: IIP (1995, updated 2016)

5.7 Climate Change

Climate change is the long-term change in the magnitude, variability and timing of various elements of earth's climate system, including the atmosphere, ocean, and cryosphere. These changes are found to occur outside the expected ranges of interannual (natural) variability and are typically determined over long timescales (e.g. 30 years).

Climate change will likely have some influence on all aspects of the climate system, although the magnitude and timing of these impacts will vary regionally. While many changes in the climate are already being observed, future changes are determined using global climate models (GCMs). There are presently over 20 widely used GCMs, most of which are included in the Coupled Model Intercomparison Project Phase 5 (CMIP5) of the World Climate Research Programme. These GCMs are driven by GHG emissions scenarios, ranging from very low (Representative Concentration Pathway, RCP 2.6) to moderate (RCP 4.5 and RCP 6.0) to high (RCP 8.5, comparable to the current path). How much the climate is projected to change (i.e. the climate change signal) depends strongly on which GCM and which GHG scenario are used. This manifests as uncertainty in climate projections. Greater uncertainty occurs when there is a wider spread of projection results across various GCMs. Higher confidence is found when GCM projections are more aligned. On a global scale there are three impacts of climate change for which long-term trends are being observed and future projections are in general agreement. The first is that average global temperatures (air and ocean) are increasing, with more extreme warming occurring in the arctic. The second is that the hydrologic cycle is intensifying as warmer air can hold more moisture, implying that precipitation events on average will tend to be more intense in the future. The third impact is that the mean global sea level is rising. There is greater uncertainty (i.e. greater spread in future projections) in regional changes.

This section discusses general climate change considerations relevant to the Flemish Pass, the Grand Banks and offshore Newfoundland and is organized according to atmospheric variables (wind, temperature, precipitation, and extreme events), oceanographic variables (ocean-water temperatures, waves, currents, and sea level), and cryospheric variables (sea ice and icebergs). As the timeline of the Project spans approximately the next decade, recent trends and variability along with medium term climate projections are presented.

5.7.1 Atmospheric Climate Changes

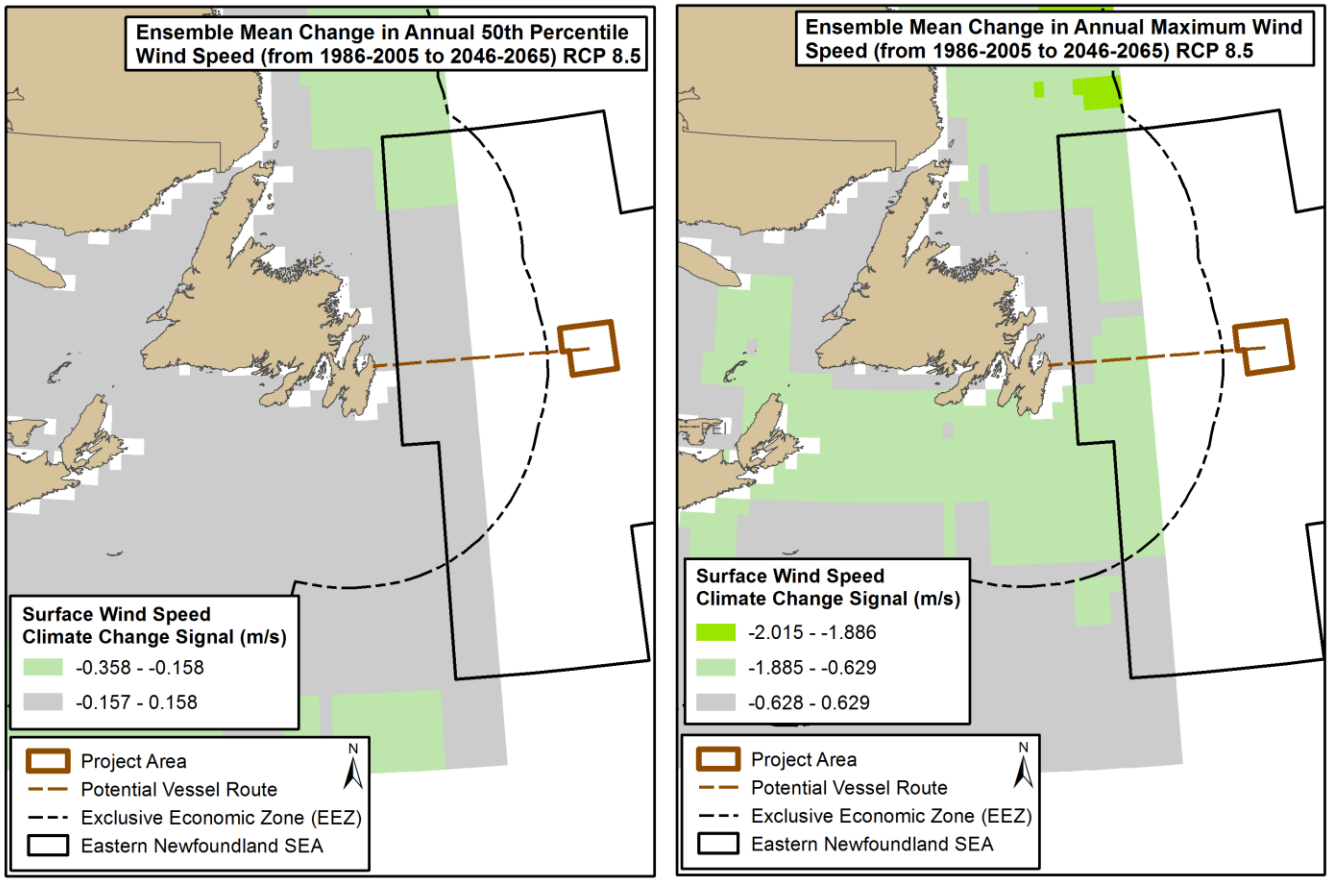
5.7.1.1 Wind

In general, winds are created as air moves from a region of high pressure to a region of low pressure. Similarly (non-tropical) storms are fueled by temperature differences and the climate's attempts to move energy from regions of high energy (i.e. high temperature) to regions of low energy. As the temperature difference (also known as the temperature gradient) between the tropics and the arctic changes, the strength of storms and the associated wind speeds will also change.

Cheng et al (2014) found that the frequency of high-speed hourly wind gusts in Atlantic Canada is expected to increase under both medium and high scenarios by the mid-21st century. Their study showed the frequency of gusts over 90 km/h could double, gusts over 70 km/h could increase by around 20 percent, and gusts over 40 km/h by 15 percent. There is uncertainty regarding wind projections as evidenced by contradictory studies.

In a more recent study using different GCMs and emissions scenarios (Amec Foster Wheeler 2017a), the median and maximum annual sustained (hourly average) wind speeds were projected to decrease slightly or remain unchanged over the coming decades. The spatial coverage of the study was primarily west of the region of interest, although it includes portions of potential supply vessel and aircraft routes to the Project Area. There was also high spatial consistency in the analysis results, allowing one to infer that the predicted impacts of climate change on the Project Area will be similarly negligible. This is illustrated by Figure 5.40, which originates from Amec Foster Wheeler (2017a).

Figure 5.40 Projected Median (Left) and Maximum (Right) Annual Sustained Wind Speeds for the Mid-21st Century, Using a Six-Member Climate Model Ensemble Forced by the RCP 8.5 GHG Scenario

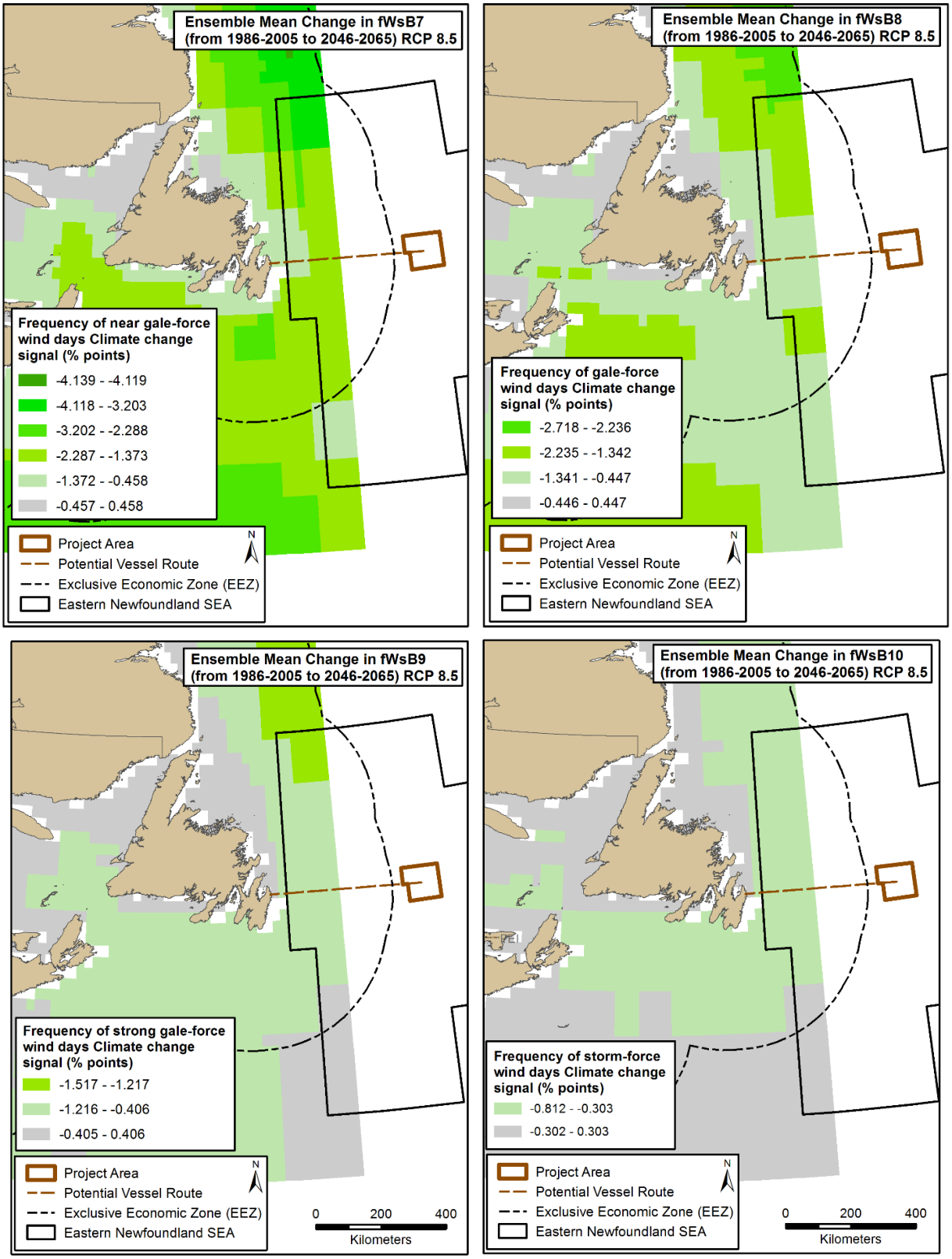


Source: Amec Foster Wheeler (2017a)

Similarly, it was found that the frequency of days that could experience sustained near gale-force winds (greater than 51.9 km/h), gale-force winds (over 62.0 km/h), strong gale-force winds (over 75.0 km/h), or storm-force winds (over 89.0 km/h) are also projected to decrease. This is illustrated in Figure 5.41.

This report also found that mean monthly wind directions are not expected to deviate significantly from present day.

Figure 5.41 Change in the Annual Percentage of Days When Daily Max Wind Speed Is >51.9 km/h (fWsB7, Top Left), >62.0 km/h (fWsB8, Top Right), >75.0 km/h (fWsB9, Bottom Left), and >89.0 km/h (fWsB10, Bottom Right)



Source: Amec Foster Wheeler (2017a)

5.7.1.2 Temperature

Air temperatures have increased in coastal meteorological stations in Eastern Canada over the 110 year record by 0.75 ±0.34°C (Savard et al 2016). Warming in the region has been found to be greater than or equal to global trends (IPCC 2013). This underlying trend is expected to continue and intensify over the coming decades. This climate change signal will be overlain on natural interannual variability, which means any given year could be warmer or cooler than the preceding year. IPCC (2014) projects that for 50-70 percent of the years in the mid-21st century the Grand Banks will experience an annual maximum temperature higher than the maximum temperature observed between 1986 and 2005.

5.7.1.3 Precipitation

IPCC (2014) also shows there is strong agreement among climate models that mean annual precipitation for the region will increase by up to 10 percent. The same report projected that the 20-year return value of annual precipitation extremes would increase by 5-10 percent by mid-century. This does not imply that there will be more precipitation events, but that the events that do occur are projected to produce more precipitation. Projected increases in both average and extreme precipitation amounts can be attributed to the intensification of the hydrologic cycle, discussed in the introduction to Section 5.7.

5.7.1.4 Storms

There is not expected to be an overall increase in the frequency of tropical storms, however, the hurricanes that do occur are projected to generally be stronger due to the effects of climate change. A higher percentage of Category 3, 4 and 5 storms than has been observed in the past is projected by Bender et al (2010). According to NOAA's National Hurricane Center, this trend has become apparent over the past several decades. The reason for this is the warming sea surface temperatures are able to provide more energy and moisture (i.e. fuel) for the tropical cyclones that do form.

With regard to winter storms, Loder et al (2013) project that there will be a northward shift in storm tracks that could affect the Project Area. This can be predominately attributed to a warming arctic and a weakened polar-equatorial temperature gradient. Stemming from this is an expected change in the location and strength of the predominantly west-to-east jet stream. A well-defined west-to-east jet stream, which results from a large temperature difference between the tropics and the arctic, is correlated with more and stronger winter storms tracking through the region. A relatively meandering jet stream associated with a weaker polar-equatorial temperature gradient will bring rise to blocking patterns (i.e. high- or low-pressure systems that stay in one place for an extended period and prevent other systems from moving on) and fewer winter storms.

5.7.2 Oceanographic Changes

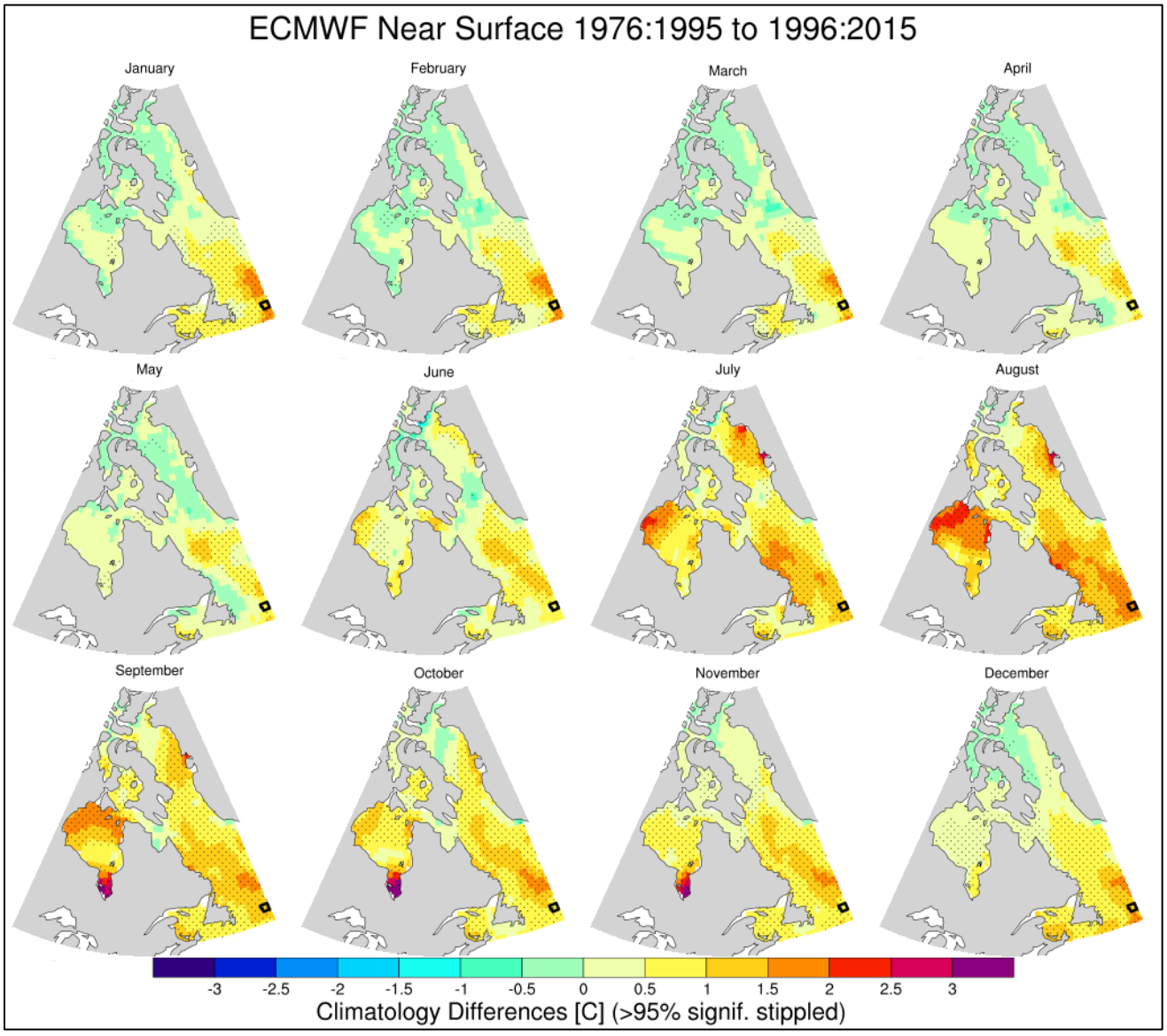
5.7.2.1 Ocean-Water Temperatures

Rising air temperatures in the region have contributed to warming surface waters, which have increased 0.32°C from 1945 to 2010 (Han et al 2013a). These warming trends are expected to continue and increase over the coming decades. Warming is expected to be less intense in waters just south of Greenland (including the northeast edge of the Project Area) due to an expected decrease in strength

of the Atlantic Meridional Overturning Circulation and associated reduction in northward heat transport (Drijfhout et al 2012). In other words, as the Gulf Stream weakens it will bring less warm water northward.

Figure 5.42 shows changes in mean monthly water temperature from 1976-1995 to 1996-2015 at approximately five metre depth, based on European Center for Medium range Weather Forecasting (ECMWF) reanalysis data. The Project Area has experienced warming in each month, although statistically significant warming (i.e. outside expected natural variability) is most prevalent from late summer to early winter. Warming was also found to be similarly widespread at depths of approximately 45 m (not shown).

Figure 5.42 Changes In Mean Monthly Water Temperature From 1976-1995 to 1996-2015 at Approximately 5 m Depth, Based on ECMWF Reanalysis Data

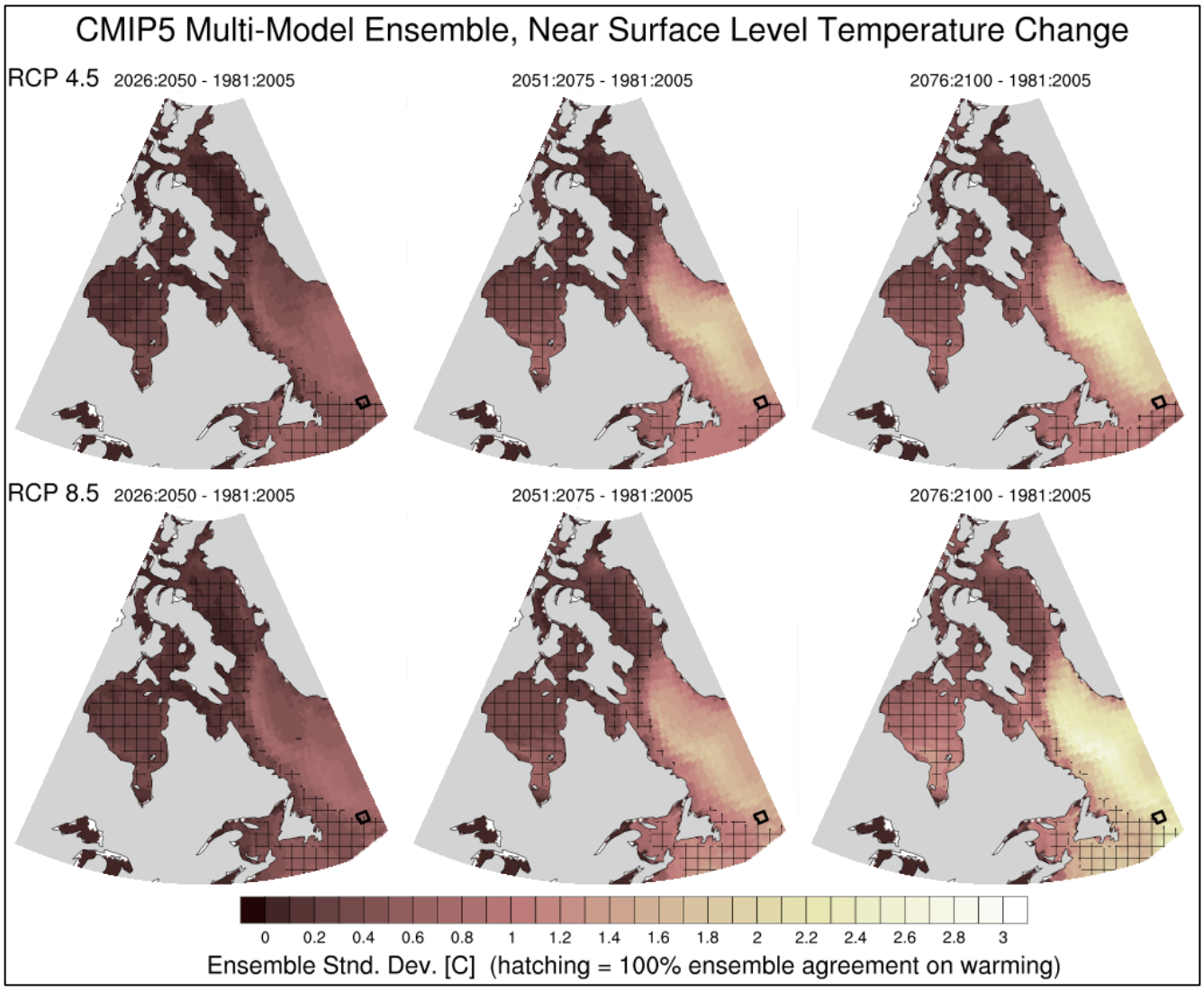


Note: Project Area outlined in black

Source: Amec Foster Wheeler (2017b)

Figure 5.43 shows model agreement and standard deviation of projected temperature changes of near surface water (five to seven metre depths) for two different GHG scenarios and three future time periods. Areas with cross hatching have 100 percent model agreement (based on an ensemble of seven CMIP5 global climate models) that there will be warming. This implies the ensemble has high confidence that near surface water temperatures will increase for a given GHG scenario and time period. The background colours represent the standard deviation of the magnitude of warming projected. This means there is greater uncertainty in the light coloured areas, which have a higher standard deviation of projections between ensemble members.

Figure 5.43 Ensemble Agreement of Projected Near-Surface Ocean-Water Temperature Projections



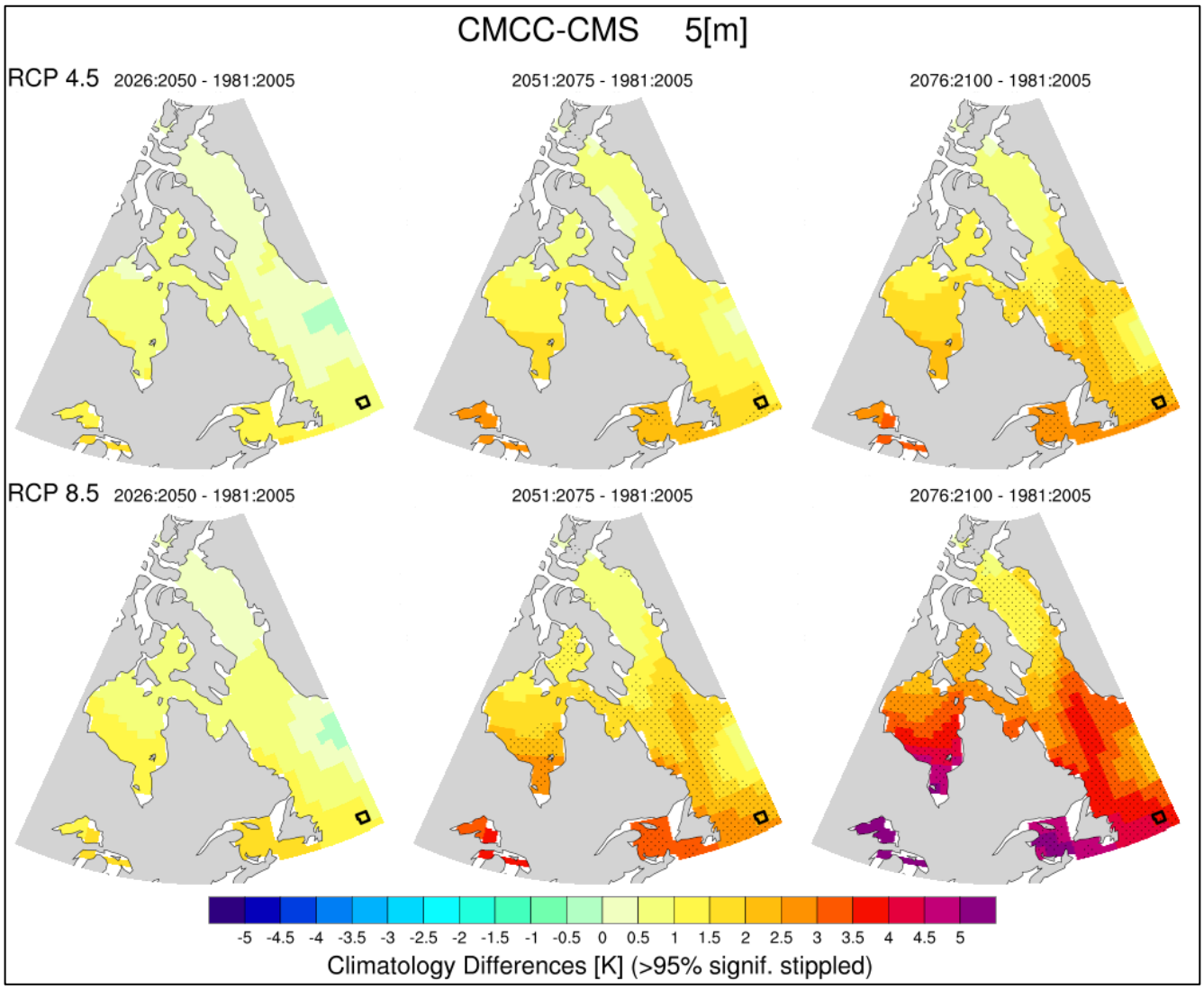
Note: Project Area outlined in black

Source: Amec Foster Wheeler (2017b)

Figure 5.44 shows a representative GCM projection (roughly in the middle of the ensemble range) from the ensemble used to create Figure 5.43. This particular model (CMCC-CMS) indicates that the next several decades will experience near surface water temperatures 1-2°C warmer than 1981-2005. As

indicated in Figure 5.43, other GCMs from the ensemble will vary in the magnitude and spatial distribution of projected temperature changes.

Figure 5.44 Representative GCM Projection of 5 m Depth Ocean Water Temperature Change



Note: Project Area outlined in black

Source: Amec Foster Wheeler (2017b)

5.7.2.2 Waves

Waves are largely driven by winds. Projections based on the latest generation of climate models show that as average sustained wind speeds are expected to decrease so are average significant wave heights (Amec Foster Wheeler 2017a). Figure 5.45, from Amec Foster Wheeler (2017a) shows that median and maximum annual wave heights are projected to decrease by mid-century. This corresponds with the projected decreases in median and maximum sustained wind speeds discussed in Section 5.7.1.1. As with Figures 5.40 and 5.41, although the spatial coverage of the study does not directly include the Project Area, the relatively high spatial consistency in the results gives confidence in extrapolation into the region.

Figure 5.45 Projected Median (Left) and Maximum (Right) Annual Wave Heights for the Mid-21st Century, Using a Six-Member Climate Model Ensemble Forced by the RCP 8.5 Greenhouse Gas Emissions Scenario

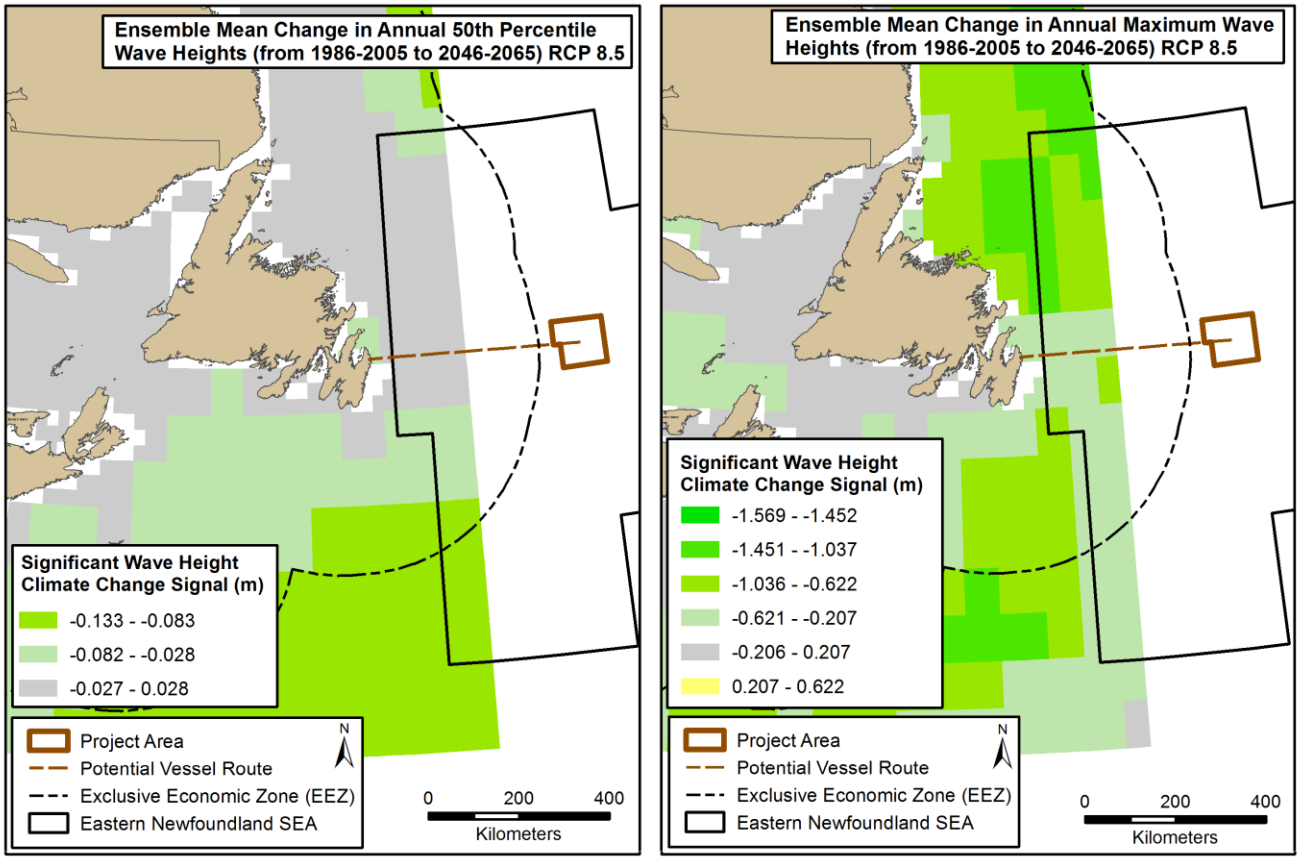
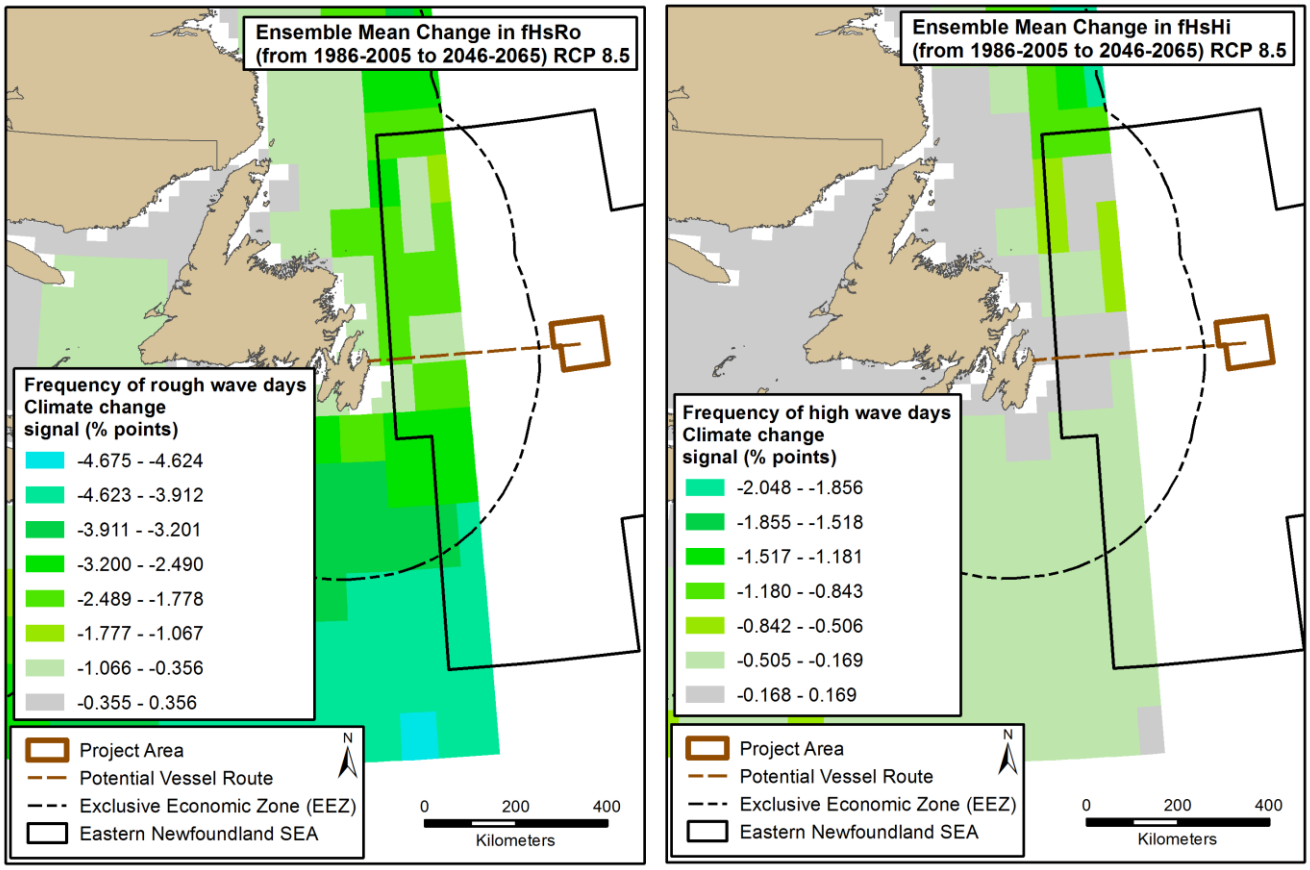


Figure 5.46 shows that the annual percentage of rough wave days (days that experience significant wave heights greater than 2.5 m) and high wave days (over 6.0 m) are also projected to decrease by mid-century. This is corroborated by Wang et al (2014) that projected decreasing significant wave heights throughout the North Atlantic Ocean.

Figure 5.46 Change in the Annual Percentage of Days When Daily Max Significant Wave Height is >2.5 m (fHsRo, Left) and >6.0 m (fHsHi, Right)



Source: Amec Foster Wheeler (2017a)

5.7.2.3 Currents

Han et al (2013b) found that the subpolar surface gyre transport (the counter-clockwise circulation of the northwestern Atlantic Ocean, of which the Labrador Current is a component and in which the region of interest resides) has been declining in the past two decades, although this is believed to be part of multi-decadal variability as opposed to a long-term downward trend.

Han et al (2013b) also found that the Labrador Current transport is positively correlated with the winter North Atlantic Oscillation (NAO) in regions north of Grand Banks slope, and negatively correlated in regions further south. The NAO is an index measuring anomalies in sea level pressure between the Icelandic low and the Azores high. What this implies is that over 1992-2011 when the NAO was generally weak, the Labrador Current extended southward beyond the Grand Banks but was weaker in strength. A potential mechanism for this is the southward shift of the Gulf Stream which correspondingly allowed this southward extension of the Labrador Current.

Rahmstorf (2006) discusses how projected increases in the melting of Greenland's ice sheet, decreases in the duration and extent of sea ice as well as increases in the rainfall over the North Atlantic could disrupt the sinking of cold, salty water. This could potentially reduce the amount of North Atlantic Deep Water formed and weaken the thermohaline circulation which would significantly alter currents and a

wide range of other climatic and oceanographic variables in the Project Area. There is a great deal of uncertainty surrounding these projections due in part to the large number of contributing factors (e.g. ice sheet dynamics, precipitation patterns, ocean circulation, etc.) and it is unlikely that significant changes to major currents in the Project Area will be experienced over the next decade.

5.7.2.4 Sea Level

Primary contributing factors to relative sea level rise include the thermal expansion of the ocean, increased water amounts from melting ice sheets and glaciers, glacial isostatic adjustments (land that is rising or falling in response to the disappearance of ice sheets from the most recent ice age), and the strength of the Gulf Stream (Yin 2012). Due to the interaction of the above factors, global sea level has risen at a rate of 3.2 ± 0.4 mm/year from 1993-2009, based on satellite altimetry (Church and White, 2011). As sea levels around Eastern Newfoundland are projected to rise on the order of 0.5 to 1 m (or more) by the end of the 21st century (James et al 2014), the rate of annual sea level rise will likely increase beyond present day trends.

5.7.3 Ice Conditions

As described in the Eastern Newfoundland SEA (Amec 2014) Section 4.1.6, the Arctic has undergone substantial warming since the mid-20th century. Greenland ice sheets have been losing mass and glaciers have continued to shrink almost worldwide over the past two decades. The average rate of ice loss from the Greenland ice sheet has increased from 34 Gt/yr over the period 1992 to 2001 to 215 Gt/yr over the period 2002 to 2011.

5.7.3.1 Sea Ice

Based on reconstructions over the past three decades, the annual mean Arctic sea ice extent decreased over the period 1979 to 2012 with a rate in the range of 3.5 to 4.1 percent per decade, and the summer sea ice minimum has similarly decreased in the range 9.4 to 13.6 percent per decade.

There is medium confidence that a nearly ice-free Arctic Ocean in September before mid-century is likely for RCP 8.5 (IPCC 2013). These ice mass reductions range from 43 percent for RCP 2.6 to 94 percent for RCP 8.5 in September and from eight percent for RCP 2.6 to 34 percent for RCP 8.5 in February (IPCC 2013). Based on these historical trends and projections for shrinking Arctic sea ice cover, it is likely that sea ice extent and ice thicknesses will be reduced in the future for offshore Newfoundland and Labrador in general, including the Project Area. The timing of freeze-up and melting and the variability and severity of ice seasons in particular are expected to change. This would be in keeping with increased northern warming as projected by Finnis (2013) for the province, with air temperatures increasing 4 to 6°C in Northern Labrador.

Newfoundland and Labrador, including the offshore, presently lacks a set of completed downscaled GCM projections for sea ice. Measurement of ice thickness can serve to validate sea ice predictions. While remote sensing technologies such as satellite imagery are used in the preparation of operational daily and weekly ice chart products (such as those from the Canadian Ice Service of Environment and Climate Change Canada), there have been no dedicated in-situ observations of sea ice thickness in Newfoundland and Labrador since the mid-1990s (the nearest active station is located in Iqaluit, Nunavut).

5.7.3.2 Icebergs

The regional iceberg climate is determined by the rate at which icebergs calve from glacial regions to the north (particularly Greenland) and their size distribution (mass and draft, and geographic distribution and circulation). Iceberg movement and deterioration, in turn, are affected by a number of factors including local oceanic and atmospheric circulation patterns, water temperature, the frequency and duration of open water conditions (influenced by sea ice extent - iceberg drift is impeded through regions of sea ice) and by a variety of factors affecting the principal iceberg source regions.

The warmer air temperatures could lead to an increase in iceberg calving rate from Greenland and Northern Canadian glaciers (Herdes et al 2012) and reduced sea ice concentrations could provide less obstructed routes from calving sites to the Project Area. While this would increase the number of icebergs in the waters off Newfoundland and Labrador, the increased sea surface temperature and wave action (from reduced sea ice cover) would increase their melt and deterioration rates. That said, the number of icebergs observed offshore Newfoundland varies widely from year to year so long-term trends may take multiple decades to become apparent.

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6 EXISTING BIOLOGICAL ENVIRONMENT

This section provides a description and regional overview of the existing biological environment, in order to support the identification and analysis of key aspects that may interact with the Project and therefore require assessment in the EIS. The description that follows focusses on the various biological VCs that have been identified as key areas of focus for the EIS (Section 4.2), including marine fish and fish habitat, marine and migratory birds, marine mammals and sea turtles, and identified special areas. These components of the biological environment and subcomponents therein are described at differing levels of detail, depending on the type and level of available information and their relevance to the Project and its EA. Although a primary focus of the description that follows is on the Project Area and LSAs for the various biological VCs involved (see Chapters 8 to 11) - as it is within these areas that most Project-environmental interactions and potential effects will occur - the description of the existing biological environment also covers the larger RSA (see Section 4.3.1), and areas beyond for regional context, where relevant and possible based on the nature and coverage of the various sources of environmental baseline information identified, accessed and used herein. Common species names are used in the text, with scientific names provided in the various tables included throughout the chapter. An overall listing of common and scientific names for key species is provided in Appendix B.

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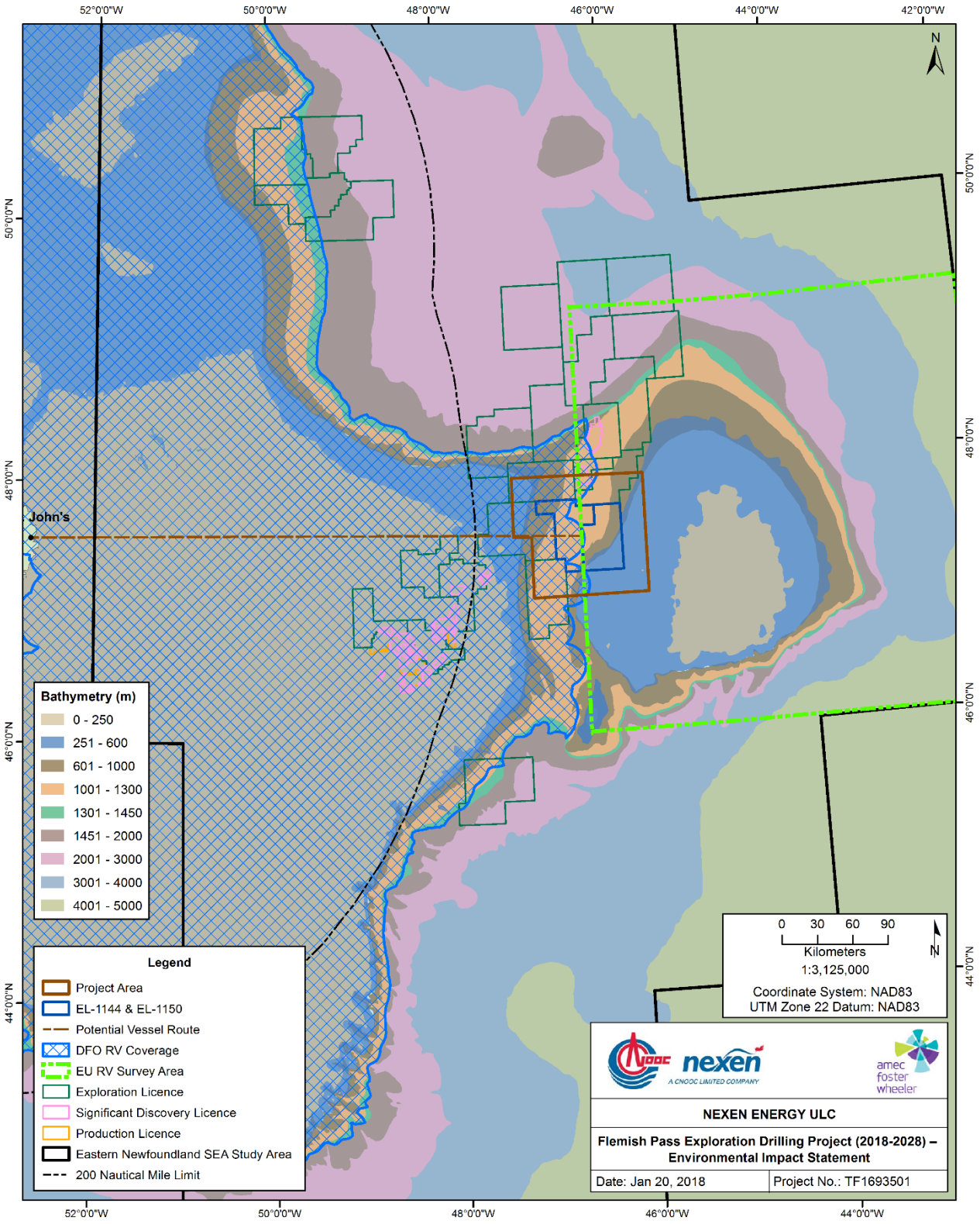
6.1 Marine Fish and Fish Habitat

Marine ecosystems are comprised of biological and physical elements that interact to form complex and variable patterns across a seascape. The physical elements of fish habitats in shallower shelf areas and continental slopes to deep abyssal areas affect the presence, abundance and distribution of marine organisms, resulting in assemblages of species associated with particular habitats. Biological ecosystem elements span primary producers such as phytoplankton to consumers such as zooplankton, invertebrates and fish that have important roles in supporting regional biodiversity and marine productivity. This chapter focuses on marine fish and fish habitat within the Project Area and surrounding area that includes shelf and slope areas of the Northeast Grand Bank, including parts of the Flemish Cap and the Flemish Pass. This includes consideration of relevant fish species (both stable and at risk), as well as plankton, algae, marine plants, benthos and relevant components of their habitats (such as water and sediment).

6.1.1 Key Data Sources and Administrative Considerations

The Project Area falls within the geographic scope of the Eastern Newfoundland SEA (Amec 2014), which provides a regional overview of the offshore marine ecosystem that includes the Grand Banks, Flemish Cap and adjacent slope and abyssal habitats (Figure 6.1). This chapter builds upon the information presented in the SEA by summarizing critical elements, augmenting SEA knowledge with more recent information available in the literature and from other more recent datasets, and providing additional analyses specific to the Project Area, LSA and associated RSA. For more detailed generic information (including descriptions of the overall characteristics and life histories of marine species) or regional ecological context, the reader is directed to the Eastern Newfoundland SEA document itself (Amec 2014, see Section 4.2.1).

Figure 6.1 Primary Depth Zones of the Project Area and Surrounding Marine Environments



Fish and fish habitat information is derived from two regulatory jurisdictions. The 200 nautical mile (NM) Exclusive Economic Zone (EEZ) regulatory jurisdiction is managed by the Government of Canada and some aspects of fish and fish habitat beyond the EEZ are managed by the North Atlantic Fisheries Organization (NAFO). The Project Area lies outside the 200 NM EEZ in NAFO managed waters. The distribution and abundance of demersal fish and invertebrates within the Project Area are relatively well studied through annual standardized multi-species government research vessel (RV) surveys by the Government of Canada within the EEZ and by NAFO and the European Union (EU) outside the EEZ. While data sets across the two jurisdictions are often not directly comparable in a quantitative manner and do not necessarily provide comprehensive and comparable coverage in all areas of interest, they collectively provide a sound qualitative understanding of the key faunal communities and the key processes that influence their presence and distribution. While it is also acknowledged that some marine habitats (especially the very deep, abyssal regions) and assemblages (particularly the pelagic) are somewhat underrepresented in the available datasets, these data do cover much of the habitat heterogeneity in and around the Project Area and much of the area that is known to be used for commercial fishing purposes.

Available data from Fisheries and Oceans Canada (DFO) research vessel (RV) surveys (2008-2012) were used as the basis for much of the description and analysis that is presented in this section. Data from these surveys include much of the Grand Banks and some areas of the continental slope outside the EEZ. These data are based on random, stratified sampling from RVs using a Campelen 1800 trawl, and provide up-to-date information that can be applied in a consistent manner across a large portion of the RSA. This includes NAFO Divisions 3KLNM. Consequently, these data are used as the foundation for defining focal species and their current distributions. Scientific studies by DFO and other researchers (e.g., Prena et al 1999; Kenchington et al 2001) detailing representative information for the LSA and RSA are also used to augment the Canadian RV survey data.

Due to the history of ecological regime shifts in the Northwest Atlantic ecosystem as established by Nogueira et al (2016, 2017), only five years of recent available data (2008-2012) was utilized for analysis. The data from the Canadian RV surveys were further screened to identify key species that occurred in high abundance (cumulatively exceeded more than 95 percent of individuals captured). From this process, 11 focal taxa (10 fish and one invertebrate species) were identified. The ecology of these species is described in greater detail and maps of their distribution are provided in the sections that follow.

Visualizations of Canadian RV-derived species distributions were generated using the GIS Spatial Analysis System (SPANS) potential mapping surface methods utilized in previous research (Han and Kulka 2007, 2009) and recent strategic and project-specific EAs (e.g., Amec 2014). The technique makes use of the geo-referenced survey catch rate data to define spatial differences in fish density and biomass. These maps are displayed and described for focal invertebrate and finfish species. Furthermore, aggregate maps are provided and described for total fish biomass, total fish abundance and fish species richness. Where possible and reasonable, inferences have been made for areas not covered by Canadian RV surveys based on distribution and respective species biology and ecology.

This information is augmented by NAFO data collected from the Flemish Cap. NAFO RV surveys of this area are also based on a stratified random design (Saborido-Rey and Vázquez 2003) and provide distribution data for a subset of commercially important species (Atlantic cod, American plaice, Greenland halibut, roughhead grenadier, and redfish). It is again recognized that certain taxa (such as

various pelagic, abyssal and infaunal species) within the area surveyed are somewhat poorly represented. Nonetheless, these sources provide useful information for a considerable portion of the RSA on many ecologically and commercially important taxa. Survey data were not directly accessible for reanalysis, however the resulting scientific literature has been used to characterize assemblages and distributions of fish (Vázquez et al 2013; Nogueira et al 2014, 2016, 2017) and invertebrate (Murillo et al 2011; 2016) species for the region based on abundance, biomass and occurrence similar to the analysis of Canadian RV survey data. Analyses were also undertaken to provide comparisons to Canadian surveys and for characterizing fish and fish habitat within the RSA. From recent publications (Nogueira et al 2017) focal fish taxa were identified and described in greater detail.

6.1.2 Use and Adequacy of Existing Environmental Information for EIS Purposes

As outlined in the preceding section, the description of existing environmental conditions for marine fish and fish habitat is based on existing information and datasets. A variety of information sources are available and have been identified and used to describe the existing (baseline) environment, which cover each of the various sub-components of this VC including plankton, plants and macro algae, pelagic macroinvertebrates, benthic invertebrates (including corals and sponges) and finfish, including species at risk. These information sources provide a good, regional understanding of existing conditions within the Project Area, LSA and RSA, which is considered adequate and appropriate for EA purposes. In particular, no key information gaps have been identified which have prevented or impeded the assessment and evaluation of potential environmental effects and the identification and proposal of mitigation in the EIS.

Section 6.1.3 of the EIS Guidelines outline the particular aspects of the fish and fish habitat VC that are required to be described in the EIS, and in doing so, note that “a benthic habitat survey (ROV / camera), including transects of seafloor *in the area of the well locations*, *may be required*” (emphasis added). As is typical for any exploration drilling program at this stage of its planning, and as described further in Chapter 2, specific wellsite locations for this Project have not yet been identified. These will be selected as Project planning progresses and available subsurface data are interpreted. As a well is drilled, additional information and data are collected that are then incorporated and included in the planning of potential wellsite locations. This concept and approach were noted in the original Project Description documentation submitted by Nexen to initiate the EA review, and is recognized in various instances in the EIS Guidelines issued by the CEA Agency (eg, Section 2.2).

This potential requirement for additional, wellsite-specific benthic information is, however, being addressed through key “post EIS” mitigation commitments being made by Nexen as part of this EIS. In particular, and as described further in Section 8.3.2, prior to the start of a drilling campaign a seabed investigation will be undertaken at the identified wellsite using a drop camera / video system to investigate the potential presence of corals and sponges in proximity to the wellsite, and drilling will not occur within a specified distance of any such colony identified through these surveys.

In the meantime, and to further address the current lack of identified wellsite locations and any gaps in benthic environmental baseline data coverage across the entire Project Area, the environmental effects predictions and the identification and application of mitigation in this EIS have been undertaken in a conservative manner. The analysis inherently assumes, for example, that an environmental component may be present in the area and within the Project’s environmental zone of influence, and therefore, is “available” for a Project-VC interaction. However, in many cases the restricted abundance and spatial

and/or temporal distributions of the various components of the VC (including corals and other sensitive benthic habitats) somewhat limits the potential for interactions and effects with the Project's relatively short-term activities and localized disturbances. In all cases, however, the post-EIS wellsite seabed investigation and associated mitigation approach outlined above will be applied to all wells drilled as part of the Project, and not just those in any identified high potential areas for corals in the Project Area as identified through the existing and available information.

As a result of the available environmental baseline data for this VC, the conservative and precautionary approach used in the environmental effects assessment, and the planned application of mitigation, the existing environmental baseline datasets are considered adequate and appropriate for the EIS, and as noted in Chapter 8, the effects assessment predictions are made with an overall high level of confidence.

6.1.3 The Offshore Marine Ecosystem, Ecological Regimes and Assemblages

Marine species have direct or indirect ecological roles in the functioning of their ecosystem (Templeman 2010; Dawe et al 2012) and their community structure may be affected by short and long term shifts in inter-species interactions and fluctuations in environmental parameters. Primary interactions between marine organisms occur through the food chain where widespread variations in predator or prey abundances can cascade to other food chain levels. In the marine environment, primary production is generated by photosynthetic phytoplankton that form the base of the food chain. Nutrients and energy flow through primary consumers such as zooplankton, planktivorous fish and invertebrates, and eventually larger fish, marine mammals and birds. Nutrients are returned to the base of the food chain by detritivores that consume dead flora and fauna.

In the Northwest Atlantic, regime shifts have occurred over the past decades where varying oceanographic conditions and levels of fishing pressure have resulted in a groundfish prey or groundfish dominated system (deYoung et al 2004; Koen-Alonso et al 2010; Templeman 2010; Dawe et al 2012; Nogueira et al 2017). Multi-decadal warming trends are also driving greater primary production in the upper layers of the water column and shifting species distributions toward the poles in response to warmer waters (Martinez et al 2016; Sundby et al 2016). Distributions of species naturally fluctuate over shorter timescales as many species migrate on daily or seasonal cycles. Entire communities may also shift their distributions in response to changing availability or distributions of prey species. For example, on an annual cycle, the RSA is visited by large pelagics (sharks, tunas.) during the warm water season, while other occupants (such as capelin and cod) may leave the area as they migrate inshore to spawn or feed (Davoren and Halden 2014). Other species (such as redfish, Greenland halibut and snow crab) are more resident in nature and prefer to remain in more stable thermal habitats on the continental slope.

As described in the Eastern Newfoundland SEA (Amec 2014), marine assemblages represent groups of organisms that through ecological preferences are adapted to coexist within a particular environment in an ecosystem (Murillo et al 2016; Noguiera et al 2017). Such assemblages are often associated with specific habitats that are a product of environmental parameters including depth, temperature, pressure, light levels, oceanographic currents, productivity, and substrate type (Gomes et al 1992; Mahon et al 1998; Murillo et al 2016; Noguiera et al 2017). In the vicinity of the Project Area, three general functional units are recognized that have characteristic environmental parameters: 1) The Grand Bank, 2) the

Flemish Cap, and 3) the Flemish Pass (Amec 2014). The continental slopes act as transition zones between these functional units and represent important fish habitat in the region (Pepin et al 2010).

The Flemish Cap is a largely distinct marine ecosystem separated from the Grand Banks shelf by the Flemish Pass. The Flemish Pass is a perched slope basin that reaches approximately 1,300 m depths and is dominated by sandy mud substrate with some areas of rocks deposited by icebergs (Murillo et al 2012). As the Labrador Current reaches the Flemish Pass, it splits with the main branch flowing southwards towards the southeastern slope of the Grand Banks and the side branch circulating around the Flemish Cap (Murillo et al 2012, see also Section 5.5.2). The quasi-permanent, anticyclonic gyre dominates the oceanography of the Flemish Cap, leading to local retention of eggs and larvae (Pérez-Rodríguez et al 2012, 2016). The highly oxygenated waters on the Flemish Cap that are strongly influenced by the Labrador Current, are also relatively nutrient rich (Barrio Frojàn et al 2012; Altuna et al 2013). These oceanographic conditions are thought to contribute to the elevated biodiversity found in these areas relative to the Grand Banks Shelf habitats (Altuna et al 2013).

The environmental characteristics of the Flemish Cap are also highly influenced by fishing activity, as evidenced by population changes to cod size and age at maturity resulting from fisheries removal of immature and early mature individuals (Pérez-Rodríguez et al 2013). The Grand Banks Shelf is relatively shallow, with areas generally less than 100 m deep. The strong influence of the Labrador Current limits the distribution of many “southern” species that occur nearby on the Tail of the Grand Banks. The Grand Banks are considered highly productive due to upwelling of nutrients in the shallow waters resulting from the mixing of the Labrador Current, shelf waters, and the Gulf Stream (Bundy et al 2000; Templeman 2010; Murillo et al 2016). In comparison to the Flemish Cap, the Grand Banks Shelf is more heavily influenced by the state of lower trophic levels and ice dynamics (Buren et al 2014). Assemblages on continental slopes are strongly influenced by depth and associated environmental parameters (Murua and de Cardenas 2005; Barrio Frojàn et al 2012; Nogueira et al 2017). Depth gradients and influence of oceanic currents act as barriers to dispersal for many shelf species into these areas (Murillo et al 2016). Habitat complexity is generally reduced at greater depths (Carter et al 1979) and assemblages may be associated with habitat forming sponges, and corals (Beazley et al 2013a; Kenchington et al 2013; Baillon et al 2014a). The following sections provide more detailed coverage of specific ecosystem elements related to marine fish and fish habitat.

6.1.4 Plankton

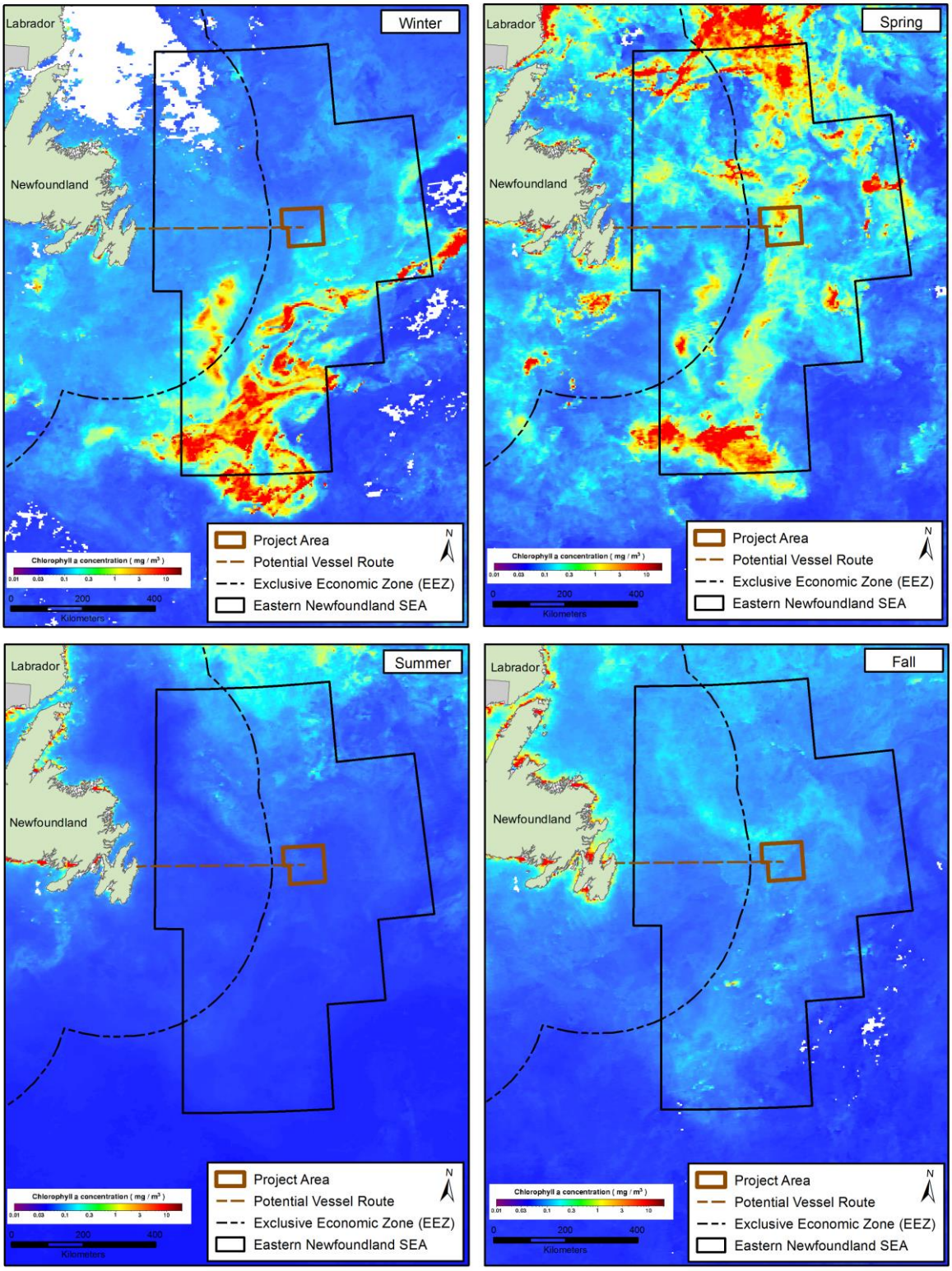
The plankton community is comprised of small free-floating microscopic marine plants (phytoplankton), invertebrates (zooplankton), vertebrate and invertebrate eggs and larvae, bacteria, fungi and viruses (Legendre and Rassoulzadegan 1995; Suttle 2005). Plankton comprise the most diverse and abundant group in the ocean and form the foundation of marine food webs through primary (phytoplankton) and secondary (zooplankton) production. Many commercially important finfish and invertebrate species occur as plankton early in their life cycle. Their early life cycles may also depend on other plankton for food. Consequently, areas and times of high plankton abundance and concentrations typically correspond with aggregations of animals higher in the food chain and spawning events (Beazley et al 2013a). Plankton also have roles in nutrient (nitrogen) and carbon cycling between the atmosphere and marine environment (biological pump) and within the marine environment (benthic-pelagic coupling; Amec 2014). The information provided below is focused on the RSA and further information on regional plankton dynamics is presented in the Eastern Newfoundland SEA (Amec 2014).

Phytoplankton are comprised of microscopic marine plants that depend on both sunlight and nutrients for growth. These two limiting factors in conjunction with oceanographic processes influence phytoplankton abundance and distribution. In western North Atlantic waters, there is a spring phytoplankton bloom where plankton abundance increases in response to strengthening sunlight and interacts with well mixed nutrient rich waters (Maillet et al 2004). A second weaker bloom occurs in the fall associated with nutrient upwelling resulting from a breakdown in the thermocline (Afanasyev et al 2001). The anticyclonic gyre near the Flemish Cap contributes to elevated temperatures and relatively higher inorganic nutrients which positively affects both primary and secondary producers (Maillet et al 2004). Plankton levels are also relatively high at shelf break areas where the thermal gradients and enhanced vertical mixing supports upwelling of nutrients (Amec 2014). Annual seasonal patterns of phytoplankton dynamics are demonstrated by satellite imagery of surface irradiance from chlorophyll a (chl a; a photosynthetic pigment in phytoplankton) that allows for tracking of phytoplankton abundance and distribution (Figure 6.2). Winter *chl a* concentrations are generally low with increasing levels in the spring season in the Flemish Pass. Over summer, the blooms dissipate as nutrients are used up in the water column and the second weaker bloom in the Fall is observed on the slopes of the Grand Banks and Flemish Cap.

In the marine food chain, zooplankton provide a key energy pathway between primary producers and the species that occupy higher trophic levels (fish, whales and seabirds) (Maillet et al 2004). The temporal and spatial variation in zooplankton abundance mirrors that of phytoplankton. Copepods make up over 80 percent of the zooplankton species richness (Dalley et al 2001; Pepin et al 2011, 2015) and the reproduction of many copepod species are coupled with the spring bloom dynamics such that early larval stages can feed during the optimal phytoplankton growth season. Zooplankton peaks in spring decline afterward as the phytoplankton food base is depleted and the zooplankton community is exposed to continual predation by other zooplankton, fish and marine mammals. The timing and availability of phytoplankton and resulting zooplankton levels have implications for survival of fish and invertebrate larvae and have been associated with condition of stocks in Atlantic cod (Minto et al 2013), capelin (Mullowney et al 2016) and Atlantic mackerel (Plourde et al 2015). Within the zooplankton community, copepods make over 80 percent of the zooplankton species richness in the Northwest Atlantic (Dalley et al 2001; Pepin et al 2010, 2015). Other important zooplankton taxa include bivalves, cladocerans, barnacles and gastropods (Dalley et al 2001; Plourde and McQuinn 2009; Pepin et al 2011, 2015). Important zooplankton taxa from the Grand Banks is summarized in the Eastern Newfoundland SEA (Amec 2014).

Dalley and Anderson (1998) described ichthyoplankton communities along both the Northeast Newfoundland Shelf and the Grand Banks as dominated by capelin, sand lance, lanternfish and Arctic cod. Other fish larvae that were regularly captured in tows included commercial species such as Atlantic cod, redfish and American plaice (Dalley and Anderson 1998; Dalley et al 2000). Wolffish, which are a species at risk (Section 6.1.8), were also captured, but with relatively low abundance. Squid larvae were also documented as being widespread across both locations. Most species (including blennies, sculpins, squid, snailfish, alligatorfish and wolffish) were more abundant on the Newfoundland Shelf than on the Grand Banks while others (such as sand lance and hake) were found predominantly over the Grand Banks (Dalley and Anderson 1998).

Figure 6.2 Distribution of Chlorophyll Irradiance Measured from NASA Satellite Imagery of the North Atlantic, Winter to Fall 2016



6.1.5 Plants and Macroalgae

Macroalgae and sea grasses serve as important features for coastal marine habitats where they enhance productivity and provide refuge to marine organisms (Amec 2014). Macroalgae are estimated to be limited to waters less than 50 m in depth due to their reliance on sunlight for photosynthesis (Anderson et al 2002) indicating that the Project Area is generally too deep to support macroalgae colonization and growth. However, there are localized areas of macroflora reported for the Virgin Rocks on the Grand Banks outside the RSA that hosts a variety of macroalgae resembling assemblages found off Labrador (Amec 2014), including kelps, understory seaweeds, coralline algae and other coldwater species.

6.1.6 Benthic Invertebrates

Benthic invertebrates represent a broad group of animals that associate with the seafloor and have key roles in ocean ecosystems. Marine invertebrates, particularly snow crab and shrimp, represent the biggest contributors to commercial fisheries landings in the region (Dawe et al 2012), but also play an important trophic role as detritivores, filter feeders and carnivores and facilitate energy transfer through the ecosystem (Amec 2014). Many benthic invertebrate species are relatively immobile, occur in relatively stable environmental conditions and therefore are regarded as being relatively sensitive to anthropogenic disturbance (Curtis et al 2013; DeBlois et al 2014; Barrio Frojàn et al 2015; Bell et al 2015; Cordes et al 2016; Clark et al 2016; Murillo et al 2016). Deep sea ecosystems such as those in the Flemish Pass also operate at a slower pace relative to shallow waters as deep sea species typically have low metabolic rates, late maturity, low levels of recruitment, slow growth rates and long life spans (Smith et al 1994, Beazley et al 2013a; McClain and Schalcher 2015; Murillo et al 2016). Recovery of deep sea habitats from disturbance can therefore be relatively slow (Clark et al 2016; Girard et al 2016).

The distribution of benthic invertebrates is highly dependent on environmental parameters as many are sessile in nature or have limited mobility and they will settle in areas that support their growth, feeding and reproduction activities (Nesis 1970; Knudby et al 2013; Gale 2013; Beazley et al 2015; Buhl-Mortensen et al 2015; Murillo et al 2016). Patterns of abundance and distribution may be shaped by habitat characteristics (Baker et al 2012), oceanographic conditions (Murillo et al 2016); predator-prey relationships (Gale et al 2015), and associations with habitat engineering organisms (e.g. corals, sponges, burrowing invertebrates; Baker et al 2012; Baillon et al 2014a; Murillo et al 2016). Water depth is considered a main predictor of invertebrate community assemblages and distributions due to its association with a host of environmental parameters, including substrate, temperature, and currents (Knudby et al 2013; Beazley and Kenchington 2015; Guijarro et al 2016; Murillo et al 2016). The Project Area and RSA contains no “typical” species for the per se, but rather the region contains a suite of species assemblages associated with depth zones and other factors.

6.1.6.1 Grand Banks Shelf

Along the western side of the RSA lies the Grand Banks Shelf and Slope that ranges from 250-600 m depths. Grand Banks Shelf and upper slope benthic communities identified for the RSA are based on representative data on the shelf (70-250 m) established from DFO research (Prena et al 1999; Kenchington et al 2001) and recent and on-going offshore petroleum production project monitoring programs (Suncor Energy 2013; Husky Energy 2017). Distributions for shrimp and crab species are based on direct sampling within and adjacent to the RSA from the Canadian RV surveys.

EEM programs for the Terra Nova (Suncor Energy 2013) and White Rose (Husky Energy 2017) petroleum producing projects in the Jeanne D'Arc Basin on the Grand Banks (to the south of the Project Area) indicate that sediment in the area is dominated by sand with lesser quantities of gravel and fines. Benthic community sampling for these programs indicated that polychaetes were the dominant infaunal species and made up over 65 percent relative abundance (Table 6.1). This group was primarily comprised of polychaetes from the families Spionidae, Paraonidae, Syllidae, and Cirratulidae. Bivalves were also relatively abundant (16 percent) in the White Rose Project area and were primarily comprised of chalky macoma (*Macoma calcarea*), from the family Tellinidae (Husky Energy 2017). Other taxa that were collected in relatively low abundances (less than 10 percent) include Crustacea, Gastropoda, Brachiopoda, Echinodermata, and Hemichordata (Suncor Energy 2013; Husky Energy 2017). Similarly, benthic grabs by Kenchington et al (2001) on sandy areas of the northeastern Grand Banks observed relatively high abundance of polychaetes from the families Spionidae and Cirratulidae. Sarsi brittle stars (*Ophiura sarsi*), Chalky macoma, and pale sea urchin (*Stongylocentrotus pallidus*) were also observed (Kenchington et al 2001).

Table 6.1 Dominant Infaunal Invertebrate (Abundance) Species Representative of the Grand Bank

Depth Zone	Survey Type	Common Name	Scientific Name	Total Abundance	Contribution to Survey
Shelf / Slope Edge 70-100 m	Benthic grab[1]	Polychaete	Polychaeta (C)	25,330	77.8%
		Amphipod	Amphipoda (C)	1,921	5.9%
		Bivalve	Bivalvia (C)	1,172	3.6%
		Gastropod	Gastropoda (C)	1,107	3.4%
		Crustacean	Cumacea (O)	1,009	3.1%
		Isopod	Tanaidacea (O)	716	2.2%
Depth Zone	**Survey Type**	**Common Name**	**Scientific Name**	**Total Abundance**	**Contribution to Survey**
Shelf / Slope Edge 70-100 m	Benthic grab[2]	Polychaete	Polychaeta (C)	nr	67%
		Amphipod	Amphipoda (C)	nr	2%
		Bivalve	Bivalvia (C)	nr	16%
		Gastropod	Gastropoda (C)	nr	1%
		Isopod	Tanaidacea (O)	nr	3%
		Echinoderm	Echinodermata (P)	nr	1%
Depth Zone	**Survey Type**	**Common Name**	**Scientific Name**	**Mean Abundance (no · 0.5m^{-2})**	**Contribution to Survey**
Shelf / Slope Edge 70-100 m	Benthic grab[3]	Polychaete	*Prionospio steenstrupi*	174.99	15.20%
		Polychaete	*Chaetozone setosa*	99.3	8.60%
		Polychaete	*Spio filicornis*	89.23	7.80%
		Polychaete	*Nothria conchylega*	nr	-
		Amphipod	*Priscillina armata*	nr	-
		Chalky macoma	*Macoma calcarea*	nr	-
		Sand dollar	*Echinarachnius parma*	nr	-

Adapted from [1]Suncor Energy (2013); [2]Husky Energy (2017); [3]Kenchington et al (2001)
nr: not reported.
Contribution to Survey: Reported percentage of total abundance, biomass, or trawl presence in the survey.

Depth Zone	Survey Type	Common Name	Scientific Name	Total Abundance	Contribution to Survey
Taxonomic groups: Order (O), Class (C); Family (F)					

Representative dominant epifaunal species for the area have been identified through underwater video surveys and trawling in the Hibernia area (Schneider et al 1987; Stantec 2013), and experimental trawling and benthic grab experiments conducted on northeast Grand Banks (Prena et al 1996, 1999; Roswell et al 1997; Kenchington et al 2001) (Table 6.2). Schneider et al (1987) observed brittle stars, sand dollars (*Echinarachnius parma*), Icelandic scallops (*Chlamys islandica*), pale sea urchins, whelks, Majidae crab, and polychaetes as the dominant taxa through towed video surveys in areas 70-100 m deep. In commercial trawl surveys around the Hibernia Platform (Stantec 2013), snow crab were the most commonly captured macroinvertebrate. On the Northeast Grand Banks, Kenchington et al (2001) reported that the biomass as collected benthic grab was dominated by propeller clam (*Cyrtodaria siliqua)*, sand dollars, brittle star, chalky macoma, and pale sea urchin. Prena et al (1999) captured snow crab, basket stars (*Gorgonocephalus sp*.), pale sea urchins in the greatest quantities using an epibenthic sled.

Table 6.2 Dominant Macrofaunal Invertebrate (Abundance, Catch per Unit Effort, and Biomass) Species Representative of the Grand Bank

Depth Zone	Survey Type	Common Name	Scientific Name	Total Abundance ($no \cdot m^{-2}$)	Contribution to Survey
Shelf / Slope Edge 70-100 m	Photograph Survey[1]	Brittle star	Ophiuroidea (O)	0.40	25.2%
		Sand dollar	*Echinarachnius parma*	0.39	24.6%
		Icelandic scallop	*Chlamys islandica*	0.37	23.0%
		Pale sea urchin	*Strongylocentrotus pallidus*	0.27	16.9%
		Whelk	Buccinidae (F)	0.04	2.8%
		Crab	Majidae (F)	0.04	2.5%
		Polychaete	Sabellidae (F)	0.02	1.2%
Depth Zone	**Survey Type**	**Common Name**	**Scientific Name**	**CPUE (abundance/tow)**	**Contribution to Survey**
Shelf / Slope Edge 70-100 m	Trawl[2]	Snow crab	*Chionoecetes opilio*	0-3	-
		Sea star	Asteroidea (O)	<2	-
Depth Zone	**Survey Type**	**Common Name**	**Scientific Name**	**Mean Biomass ($mg \cdot 0.5m^{-2}$)**	**Contribution to Survey**
Shelf / Slope Edge 120-146 m	Benthic grab[3]	Propeller clam	*Cyrtodaria siliqua*	nr	-
		Sand dollar	*Echinarachnius parma*	155,283.30	-
		Brittle star	*Ophiura sarsi*	nr	-
		Chalky macoma	*Macoma calcarea*	nr	-
		Pale sea urchin	*Strongylocentrotus pallidus*	nr	-
Depth Zone	**Survey Type**	**Common Name**	**Scientific Name**	**Mean Biomass ($g \cdot m^{-2}$)**	**Contribution to Survey**
Shelf / Slope Edge 120-250 m	Trawl[4]	Sand dollar	*Echinarachnius parma*	257.7	65.0%
		Brittle star	*Ophiura sarsi*	74.0	18.7%
		Pale sea urchin	*Strongylocentrotus pallidus*	34.7	8.7%
		Boreal astarte	*Astarte borealis*	6.8	1.7%

Depth Zone	Survey Type	Common Name	Scientific Name	Total Abundance (no · m^{-2})	Contribution to Survey
		Snow crab	*Chionoecetes opilio*	7.2	1.8%
		Soft coral	*Gersemia sp.*	2.6	0.6%
Depth Zone	**Survey Type**	**Common Name**	**Scientific Name**	**CPUE (abundance/tow)**	**Contribution to Survey**
Shelf / Slope Edge	Trawl[5]	Northern shrimp	*Pandalus borealis*	315.5	96.8%
		Shrimp	*Atlantopandalus propinqvus*	10.1	3.1%
		Snow crab	*Chionoecetes opilio*	0.5	0.2%

Adapted from [1]Schneider et al (1987); [2]Stantec 2013; [3]Kenchington et al (2001); [4]Prena et al (1999); [5]Canadian RV Data 2008-2012 (based on 34 tows inside the Project Area).
nr: not reported.
Contribution to survey: Reported percentage of total abundance, biomass, or trawl presence in the survey.
Taxonomic groups: Order (O), Family (F)

The available data from Canadian RV surveys are admittedly biased towards commercial invertebrate species and report shrimp species (*P. borealis* and *Atlantopandalus propinqvus*) and snow crab. Northern shrimp were the most dominant invertebrate species, representing 96.8 percent of individual invertebrate species captured. The other shrimp species and snow crab had relatively low abundance in the Project Area, comprising 3.1 percent and less than one percent of individual invertebrates captured. Of the species observed on the Grand Bank, sand dollars and brittle stars appear to be the most dominant benthic invertebrates within the region.

6.1.6.2 Flemish Cap

Along the eastern side of the Project Area lies the Flemish Cap Shelf and upper slope that range from approximately 250-600 m in depth. Characteristic species of benthic assemblages were identified are based on representative sampling and analysis from commercial by-catch logs and EU RV surveys within and adjacent to the RSA (Murillo et al 2011; 2016) including EL 1150 and areas of EL 1144.

Murillo et al (2016) modelled the substrate based on available box corer sediment sampling data from the area. The Flemish Cap is predominantly covered in sand and silty-sand with areas of gravel, becoming increasingly covered in silty-sand along the slopes (200-500 m). At relatively shallow depths (less than 500 m) where there were relatively colder, fresher waters, widely occurring species included sponges, crustaceans, sea anemones and sea stars (Nesis 1970; Murillo et al 2016). Assemblage species characteristic for the upper slope of Flemish Cap (200-340 m) included the sea anemone *Hormathia digitata* and the sea star *Ceramaster granularis* (Table 6.3). At further depths, on the silty-sand bottoms, characteristic species included the sea stars *Ponaster tenuispinus* and *Ctenodiscus crispatus*, and the sea urchin *Brisaster fragilis* (Murillo et al 2016). Altuna et al (2013) identified five species of hydrozoans collected from the Flemish Cap, Flemish Pass, and Grand Banks from various towed bottom surveys with the highest catch rates on the Flemish Cap shelf and slopes (240-1,885 m).

Table 6.3 Dominant Invertebrate Species Representative of the Flemish Cap and Upper Slope

Depth Zone	Survey Type	Common Name	Scientific Name	No. of Trawls present	Contribution to Survey
Shelf / Slope Edge 200-340 m	Trawl[1]	Sea star	*Ceramaster granularis*	63	35.8%
		Subarctic sea anemone	*Hormathia digitata*	39	22.2%
Shelf / Slope Edge 300-500 m	Trawl[1]	Sea star	*Brisaster fragilis*	28	15.9%
		Sea star	*Ctenodiscus crispatus*	15	8.5%

6.1.6.3 Flemish Pass

The Flemish Pass, including the middle to deep slopes of the Grand Banks and Flemish Cap, ranges in depth from 600-1,300 m. Data from Canadian (Beazley et al 2013a,b, Beazley and Kenchington 2015) and EU RV (Barrio Frojàn et al 2015; Murillo et al 2011; 2016) surveys within and adjacent to the RSA including EL 1150 and EL 1144, provide information on characteristic species for various depth assemblages.

Along the slopes and deeper areas (500-1,400 m) of the Flemish Cap and Pass, the substrate is increasingly silty-clay or mud at greater depths (Murillo et al 2011; 2012; 2016). Beazley et al (2015) identified 527 epifaunal species / morphotypes from 400-1,400 m depths in the Flemish Pass and western Flemish Cap. Sponges and cnidarians represented the highest number of taxa followed by arthropods echinoderms, and molluscs (Table 6.4, Beazley et al 2015). Infaunal sampling in the Flemish Pass by Barrio Frojàn et al (2015) identified polychaetes, nematodes, brittle stars, sponges, and hydrozoans as characteristic species. The Flemish Pass had the lowest capture rate of five hydrozoan species in surveys of the Flemish Pass, Flemish Cap and Grand Banks (Altuna et al 2013), however, this was potentially due to the lower range of depths in the area.

Table 6.4 Dominant Invertebrate Species of the Flemish Pass

Depth Zone	Survey Type	Common Name	Scientific Name	No. of Trawls present	Contribution to Survey
Middle Slope 500-900 m	Trawl[1]	Cup coral	*Flabellum alabastrum*	43	24.4%
		Soft coral	*Heteropolypus sol*	41	23.3%
		Sea pen	*Funiculina quadrangularis*	39	22.2%
		Small gorgonian coral	*Acanella arbuscula*	29	16.5%
		Black coral	*Stauropathes artica*	23	13.1%
Depth Zone	**Survey Type**	**Common Name**	**Scientific Name**	**Abundance (no · m^{-2})**	**Contribution to Survey**
Middle-Deep Slope 444-1411 m	Photograph Survey[2]	Sponges	Porifera (P)	11,091	37.2%
		Echinoderms	Echinodermata (P)	6,983	23.4%
		Cnidarians	Cnidaria (P)	3,019	10.1%
		Arthropods	Arthropoda (P)	2,152	7.2%
		Unidentified	Unidentified	2,072	6.9%
		Chordates	Chordata (P)	1,973	6.6%
		Annelids	Annelida (P)	1,145	3.8%

Depth Zone	Survey Type	Common Name	Scientific Name	No. of Trawls present	Contribution to Survey
Middle-Deep Slope 800-1,200 m	Trawl[1]	Sea pen	*Anthoptilum grandiflorum*	75	42.6%
		Sea urchin	*Phormosoma placenta*	44	25.0%
		Sea pen	*Halipteris finmarchica*	40	22.7%
		Sea pen	*Funiculina quadrangularis*	39	22.2%
		Sea pen	*Pennatula aculeata*	25	14.2%
		Sea star	*Bathybiaster vexillifer*	15	8.5%
		Sea star	*Zoroaster fulgens*	11	6.3%
Middle-Deep Slope 700-1,400 m	Trawl[1]	Sponge	*Stryphnus fortis*	20	11.4%
		Sponge	*Geodia parva-phlegraei*	10	5.7%
		Sponge	*Craniella cranium*	12	6.8%
		Sponge	*Geodia barretti*	9	5.1%
		Sponge	*Stelletta normani*	9	5.1%
Adapted from [1]Murillo et al (2016) and [2]Beazley et al (2013). Murillo et al (2016) number of trawls present is based on 176 trawls of the Flemish Cap and indicates presence among total number of trawls. Contribution to survey: Reported percentage of total abundance, biomass, or trawl presence in the survey. Taxonomic group: Phylum (P)					

Along the slopes of the Flemish Pass, Nesis (1970) observed increasing biomass with increasing depth up to 1,500 m. Benthic assemblages along the silty-sand lower slope areas at 800-1,200 m depths were characterized by echinoderms and sea pens (Murillo et al 2016). In deeper areas of the Flemish Pass and Flemish Cap, habitat complexity decreased with depth with a higher prevalence of mud substrates. The presence of structure forming sponges and corals are key to supporting benthic communities (Beazley et al 2013a) as they provide habitat, refuge and foraging areas for a variety of species.

Echinoderms, in particular suspension feeding brittle stars, are highly responsive to presence of structure forming sponge grounds (Beazley et al 2013a; Beazley and Kenchington 2015). In the Flemish Pass, this is evidenced by the shift in benthic communities (between 1,000-1,300 m) that corresponds to a distinct change in the density of sponges. In coral distribution surveys by Murillo et al (2011), the Flemish Pass was identified as having the highest average coral biomass between 600-900 m depths and the slope of the Flemish Cap between 600-1,200 m depth had the highest species richness. These benthic assemblages were typified by a variety of coral species including black corals, cup corals, sea pens, soft corals and gorgonian corals.

6.1.6.4 Key Invertebrate Species

Northern shrimp are important commercial species on the Grand Banks (Dawe et al 2012) and were the most abundant invertebrate species captured in the Canadian RV survey catches, having benefitted from cooling water temperatures and groundfish collapses of the 1990s (Lilly et al 2000; Ramseier et al 2000). More recently, shrimp stocks are declining in the southern part of their range (Orr et al 2011). Recruitment for shrimp species are affected by the strength of phytoplankton blooms and sea surface temperatures (Ouellet et al 2011). Growth rates are also influenced by latitude (Fuentes-Yaco et al 2007) and the availability of particulate organic carbon (such as detritus from decomposing phytoplankton; Ramseier et al 2000). Like many other types of zooplankton, young male Northern

shrimp exhibit nocturnal feeding migrations. However, as they age, they morph into females and become more associated with the seafloor (Fuentes-Yaco et al 2007; Templeman 2010).

Northern shrimp in the Project Area and larger RSA are concentrated primarily in the Flemish Pass and northeastern Grand Banks areas (Figure 6.3). There are relatively low abundances of Northern shrimp on the eastern Flemish Cap in comparison to the western Flemish Cap (Figure 6.4).

Figure 6.3 Distribution of Northern Shrimp Based on Canadian RV Surveys (2008-2012)

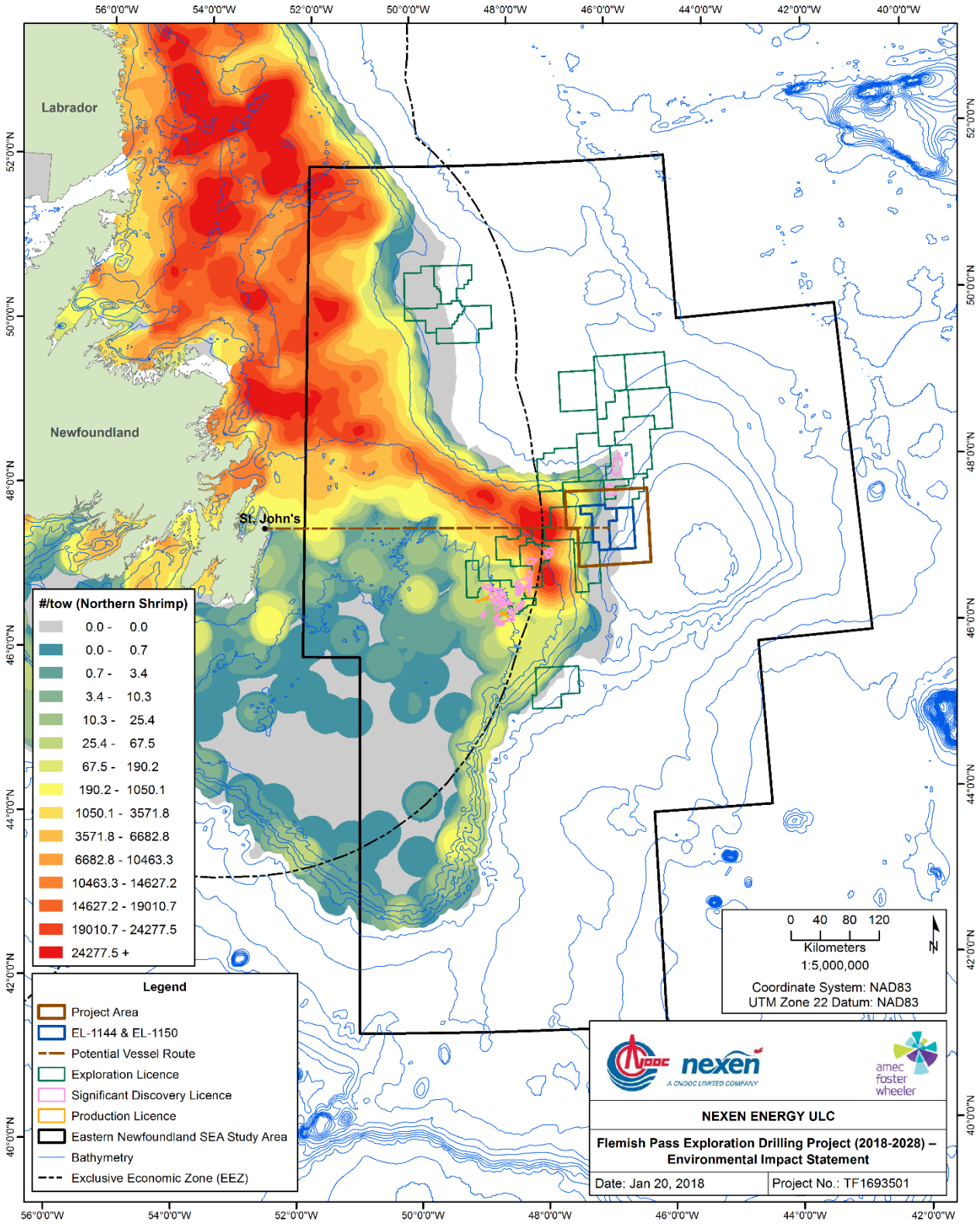
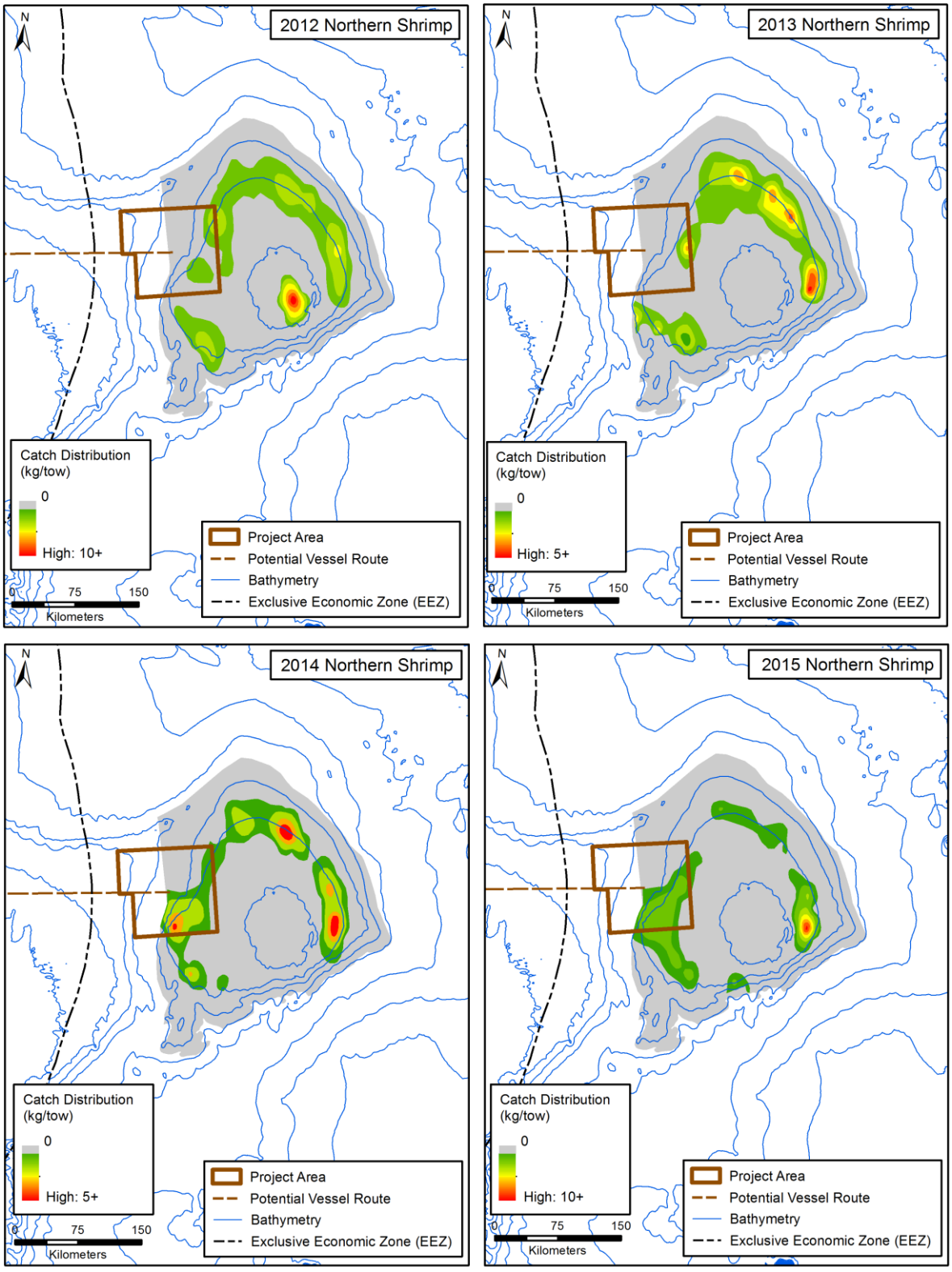


Figure 6.4 Distribution of Northern Shrimp Based on Flemish Cap EU RV Surveys (2012-2015)



6.1.6.5 Corals and Sponges

Deep-sea corals and sponges are a subset of benthic invertebrates that are of particular conservation interest due to their habitat-forming capacity and their sensitivity to anthropogenic stressors (Murillo et al 2011; Beazley et al 2013a). Deep-sea corals and sponges increase biodiversity and habitat heterogeneity in the deep sea system (WGEFAM 2008; Buhl-Mortensen et al 2010; Beazley et al 2013a) by creating vertical structure that is used as refuge and foraging habitat (Watanabe et al 2009; WGEFAM 2008) for a variety of species that include those of commercial importance (Gilkinson and Edinger 2009; Baillon et al 2012). The fragile nature and slow growth of these animals mean that disturbance to bottom habitats (such as trawling, infrastructure placement) can have important and long-lasting effects (Campbell and Simms 2009, Watanabe et al 2009; Barrio Frojàn et al 2012; Bell et al 2015, Clark et al 2016). Black corals as well as large and small gorgonian corals, which have carbonate skeletons, are considered to be amongst the most sensitive to disturbance because they can be permanently dislodged from substrate (Gilkinson and Edinger 2009). This vulnerability has resulted in partial fishing closures within several known coral and sponge areas (Section 6.4).

There are at least 56 species of corals and sea pens distributed on the Flemish Cap, Flemish Pass and the Grand Banks (within and outside the Project Area and RSA), as determined by previous bottom trawling and video surveys (Table 6.5) (Gilkinson and Edinger 2009; Wareham 2009; Murillo et al 2013; Beazley et al 2013a, Vàzquez et al 2013; Baillon et al 2014a,b; Beazley and Kenchington 2015). Along shelf and slope areas, depth along with associated environmental parameters, is considered the greatest predictor for coral presence (Guijarro et al 2016). This supports the association of coral species to specific depth ranges, particularly on shelf slope (Figure 6.5). Coral presence predictions have been limited to areas of known coral distributions (over 2,000 m depth).

Table 6.5 Corals Occurring within the Project Area and Adjacent Marine Environments

Order	Group	Species	Depth Range (m)	Flemish Cap	Flemish Pass	NE Grand Bank	Reference
Antipatharia	Black-wire corals	*Bathypathes* spp.	-	●	●		1
		Leiopathes sp.	-		●		2
		Stauropathes artica	480-970	●	●	●	1; 2; 5; 8
		Stauropathes magna	-		●		3
		Stichopathes sp.	243	●			2; 5; 8
Alcyonacea	Large gorgonians	*Acanella arbuscula*	480-1,442	●	●	●	1; 2; 5; 6
		Keratoisis ornata	-		●		1
		Keratoisis sp.	-	●	●		2; 3
		Keratoisis cf. siemensii	979-1,374	●			
		Paragorgia sp.	-	●			5
		Paragorgia arborea	250-750		●	●	1; 2
		Paragorgia johnsoni	1,079-1,351	●			2; 8
		Paramuricea sp.	-	●			2; 5

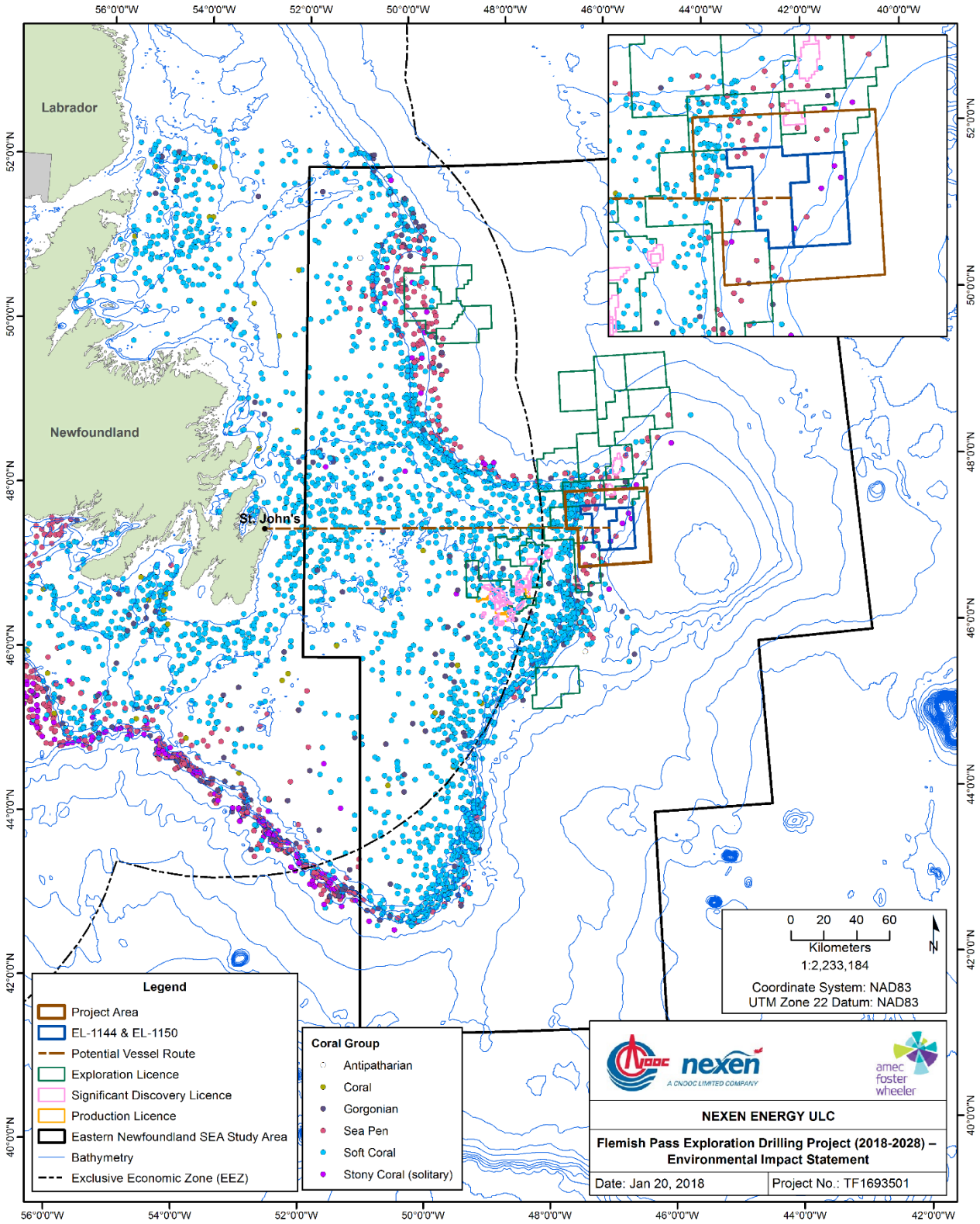
Order	Group	Species	Depth Range (m)	Flemish Cap	Flemish Pass	NE Grand Bank	Reference
		Paramuricea spp.	335-1,351	●	●	●	1; 2; 3; 8
		Paramuricea grandis	1,094-1,216	●			8
		Paramuricea placomus	494-646	●			8
		Parastenella atlantica	1351	●			2; 8
		Placogorgia sp.	404-423	●			2; 8
		Primnoa resedaeformis	527	●		●	1, 2; 5; 8
		Swiftia sp.	984-1,332	●			2; 5; 8
	Small gorgonians	*Acanthogorgia* sp.	-	●	●		3; 5
		Acanthogorgia armata	494-1,351		●		1; 8
		Anthothela sp.	-	●			5
		Anthothela grandiflora	707-1,351	●	●		1; 2; 6; 8
		Radicipes sp.	-	●			5
		Radicipes gracilis	416-1,370	●	●		1; 2; 8
	Soft corals	*Anthomastus grandiflorus*	612	●	●		1; 8
		Anthomastus sp.	-	●	●		2; 5
		Anthomastus spp.	1,095-1,370	●	●		2; 8
		Anthothela grandiflora	707-1,351	●			2; 8
		Clavulariidae species	228-1,290	●			2; 8
		Drifa glomerata	47-1,370	●			8
		Duva florida	56-1,374	●	●	●	1; 2; 5; 7; 8
		Gersemia sp.	-	●		●	1, 5
		Gersemia fruticosa	110	●			8
		Gersemia rubiformis	46-246		●	●	1; 2; 8
		Heteropolypus sp.	-	●			5
		Heteropolypus cf. insolitus	-		●		6
		Heteropolypus sol	348-1,290	●			8
		Nephtheidae indet.	-	●	●	●	2
		Pseudoanthomastus agaricus	624-1,351	●			8
		Telestula septentrionalis	494-1,332	●			2; 8
Scleractinia	Solitary stony corals	*Flabellum alabastrum*	359-1,189	●	●	●	1; 2; 8
		Flabellum angulare	-		●		6
		Desmophylllum dianthus	-	●	●		2
Pennatulacea	Sea pens	*Anthoptilum* sp.	-	●	●		3; 5

Order	Group	Species	Depth Range (m)	Flemish Cap	Flemish Pass	NE Grand Bank	Reference
		Anthoptilum grandiflorum	200-1,370	●	●	●	1; 2; 4; 8
		Distichoptilum gracile	727-1,020	●	●		2; 5; 8
		Funiculina quadrangularis	476-1,258	●	●		1; 2; 5; 8
		Halipteris sp.	-		●		3; 6
		Halipteris cf. christii	169-290	●			2; 5; 8
		Halipteris finmarchica	320-1,370	●	●	●	1; 2; 4; 5; 8
		Kophobelemnon stelliferum	657-1,258	●			2; 5; 8
		Kophobelemnon sp.	-		●		3; 6
		Pennatula sp.	-	●	●		3; 5; 6
		Pennatula aculeata	302-1189	●	●	●	2; 5; 8
		Pennatula grandis	324-1,246	●	●	●	1; 2; 5; 8
		Pennatula phosphorea	-		●		1
		Protoptilum sp.	-	●			2
		Protoptilum carpenter	973	●			8
		Umbellula sp.	-	●			5
		Umbellula lindahli	402-1,370	●	●		1; 2; 8
		Unidentified Sea Pens	-	●	●		1
		Virgularia sp.	-	●			2
		Virgularia mirabilis	1,343	●			8

Sources: Based on [1]Wareham (2009); [2]Murillo et al (2011); [3]Beazley et al (2013b), [4]Vàzquez et al (2013); [5]Baillon et al (2014a); [6]Beazley and Kenchington (2015); [7]Greenan et al (2016); [8]Murillo et al (2016)
Listed depth ranges are from Murillo et al (2016) and Buhl-Mortensen et al (2015).

Regionally, the slopes of the Flemish Pass, the Flemish Cap and Grand Banks have the highest abundance of corals between 600-1,300 m depths. Soft corals, mainly comprised of *Duva florida* and *Anthomastus spp*., are the most commonly captured deep water coral in the area with high abundance between 600-900 m depth on the northeastern slope of the Grand Banks, the Flemish Cap and the Flemish Pass (Murillo et al 2011). Sea pens have a relatively high distribution on the Flemish Cap with high abundances at 900-1,200 m depths (Murillo et al 2011). The most commonly occurring sea pens were *Antoptilum grandiflorum, Funiculina quadrangularis, Pennatula aculeata,* and *Halipteris finmarchica.* Black wire corals, comprised mainly of Stauropathes arctica, *Stichopathes sp.* and *Leiopathes sp.* appear to have areas of relatively high abundance south of the Project Area at depths of 600-1,200 m. While gorgonian corals have been captured in the area as well, with areas of high biomass of this coral group occurring mainly in the southern Flemish Pass outside the area at depths between 1,200-1,300 m (Murillo et al 2011). Cup corals were also mainly distributed outside the Project Area between 900-1,200 m depth.

Figure 6.5 Coral Distribution Based on Canadian RV Surveys (2005-2015)



Based on Canadian RV surveys within the boundaries of the Project Area itself (as illustrated in Figures 6.1 and 6.5), sea pens were the most commonly observed corals in EL 1144 including *Anthoptilum grandiflorum, Halipteris finmarchica*, and *Pennatula phosphorea*. A mixture of coral species were also collected in EL 1150 including a sea pen A*. grandiflorum*, a soft coral *Anthomastus sp*., and a solitary stony coral *Flabellum alabastrum*. In the remainder of the Project Area (which includes areas of the Grand Banks Slope and Shelf), soft corals including *Duva florida* and *Nephtheidae* species and the sea pen *A. grandiflorum* were the most commonly collected species (Table 6.6).

Table 6.6 Coral Percent Presence in Trawls in the Project Area based on Canadian RV Surveys (2005-2015)

Coral Species	EL 1144 600-1,300 m (6)		EL 1150 250-1,300 m (5)		Remainder of Project Area 250-1,300 m (83)	
	No. of Trawls Species Present	% of Trawls Species Present	No. of Trawls Species Present	% of Trawls Species Present	No. of Trawls Species Present	% of Trawls Species Present
Black Wire Coral						
Antipatharian sp.	-	-	-	-	1	1.2
Stauropathes arctica	-	-	2	40.0	4	4.8
Gorgonian						
Acanella arbuscula	-	-	3	60.0	4	4.8
Acanthogorgia armata	-	-	-	-	1	1.2
Paragorgia arborea	-	-	-	-	2	2.4
Paramuricea placomus	-	-	-	-	1	1.2
Radicipes gracilis	1	16.7	-	-	-	0.0
Sea Pen						
Anthoptilum grandiflorum	2	33.3	4	80.0	15	18.1
Distichoptilum gracile	-	-	-	-	1	1.2
Funiculinia quandrangularis	1	16.7	1	20.0	4	4.8
Halipteris finmarchica	2	33.3	2	40.0	6	7.2
Pennatula aculeata	1	16.7	-	-	6	7.2
Pennatula phosphorea	2	33.3	-	-	-	-
Pennatula grandis	1	16.7	2	40.0	5	6.0
Pennatula sp.	1	16.7	2	40.0	8	9.6
Sea pen sp.	1	16.7	1	20.0	5	6.0
Umbellula sp.	-	-	1	20.0	1	1.2
Soft Coral						
Anthomastus sp.	1	16.7	1	80.0	3	3.6
Drifa glomerata	-	-	-	-	1	1.2
Drifa sp.	-	-	-	-	1	1.2
Duva florida	2	33.3	2	20.0	65	78.3
Gersemia sp.	-	-	-	-	11	13.3
Nephtheidae sp.	-	-	-	20.0	15	18.1
Solitary Stony Coral						
Flabellum alabastrum	-	-	-	80.0	2	2.4
*Number of trawls in each areas is noted in brackets						

In addition to the above referenced DFO RV surveys, EU and Canadian survey data were previously utilized to establish VMEs based on indicator species including sea pens, large gorgonian corals and small gorgonian corals (Kenchington et al 2014, 2017). The summary data from the EU Spanish trawl survey were accessed and utilized to establish and summarize coral presence of these groups inside the Project Area (Table 6.7 and Figures 6.6 to 6.8, adapted from Kenchington et al 2017).

Sea pens were the main coral group observed across areas with higher densities on the slopes and bottoms of the Flemish Pass (Figure 6.6). Key species in this group included *Anthoptilum grandiflorum*, *Halipteris finmarchica*, and *Pennatula aculeata* (Murillo et al 2011; Kenchington et al 2014a). This coral group were present in 79.6 percent and 82.1 percent of trawls in EL 1144 and EL 1150 respectively. In the remainder of the area surrounding the ELs, sea pens were present in 64 percent of the trawls.

Gorgonian corals were not well distributed across the Project Area with primary occurrence on the slopes and in the Flemish Pass south of the ELs (Figures 6.7 and 6.8). Small gorgonian corals in trawl surveys were comprised mainly of *Acanella arbuscular* and *Radicipes gracilis* (Murillo et al 2011; Kenchington et al 2014a) and were present in from 6.1-13.9 percent of trawls across these areas (Table 6.7). Large Gorgonian corals were only observed in the area outside of the ELs in 4.8 percent of trawls and were mainly comprised of *Acanthogorgia spp, Keratoisis spp, Paragorgia aborea, P. johnsoni, Paramuricea spp,* and *Primnoa resedaeformis.*

Table 6.7 Coral Percent Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013)

Coral Species	EL 1144 600-1,300 m (49)		EL 1150 250-1,300m (28)		Remainder of Project Area 250-1,300 m (209)	
	No of Trawl Species present	% of Trawls Species Present	No of Trawl Species present	% of Trawls Species Present	No of Trawl Species present	% of Trawls Species Present
Large Gorgonian	-	-	-	-	10	4.8
Small Gorgonian	3	6.1	3	10.7	29	13.9
Sea Pen	39	79.6	23	82.1	134	64.1
Source: Adapted from Kenchington et al (2014b; 2017)						

Figure 6.6 Sea Pen Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013)

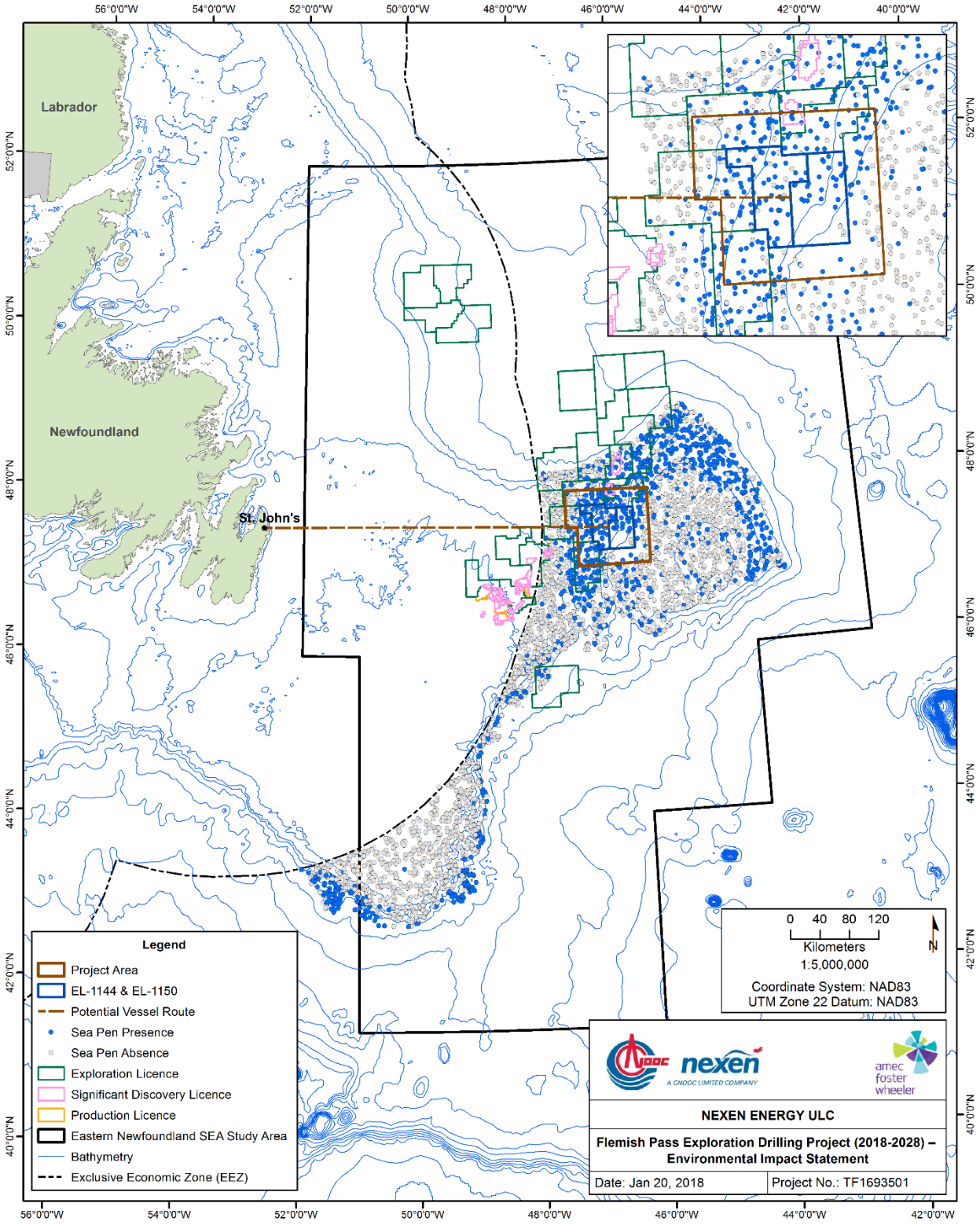


Figure 6.7 Small Gorgonian Coral Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013)

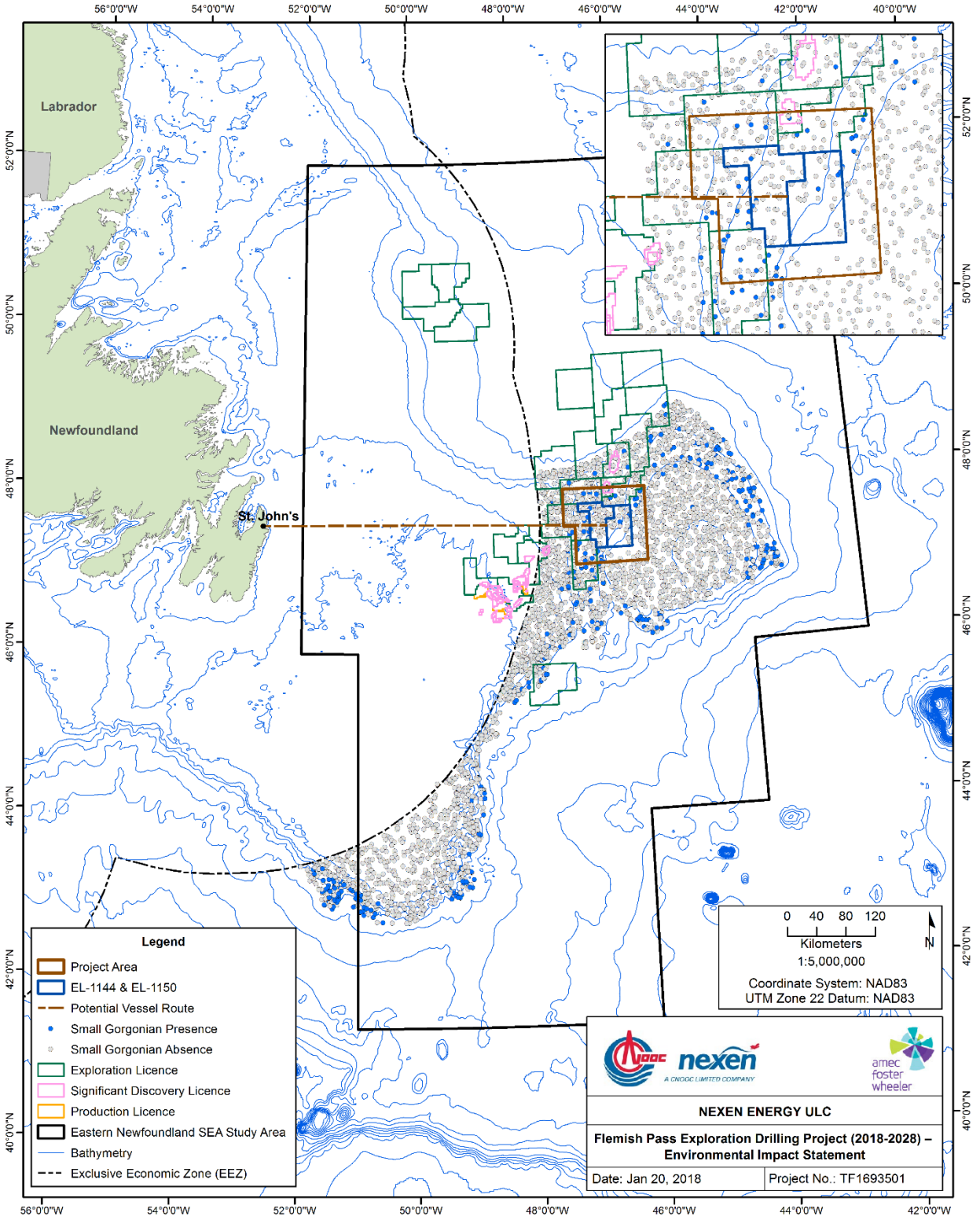
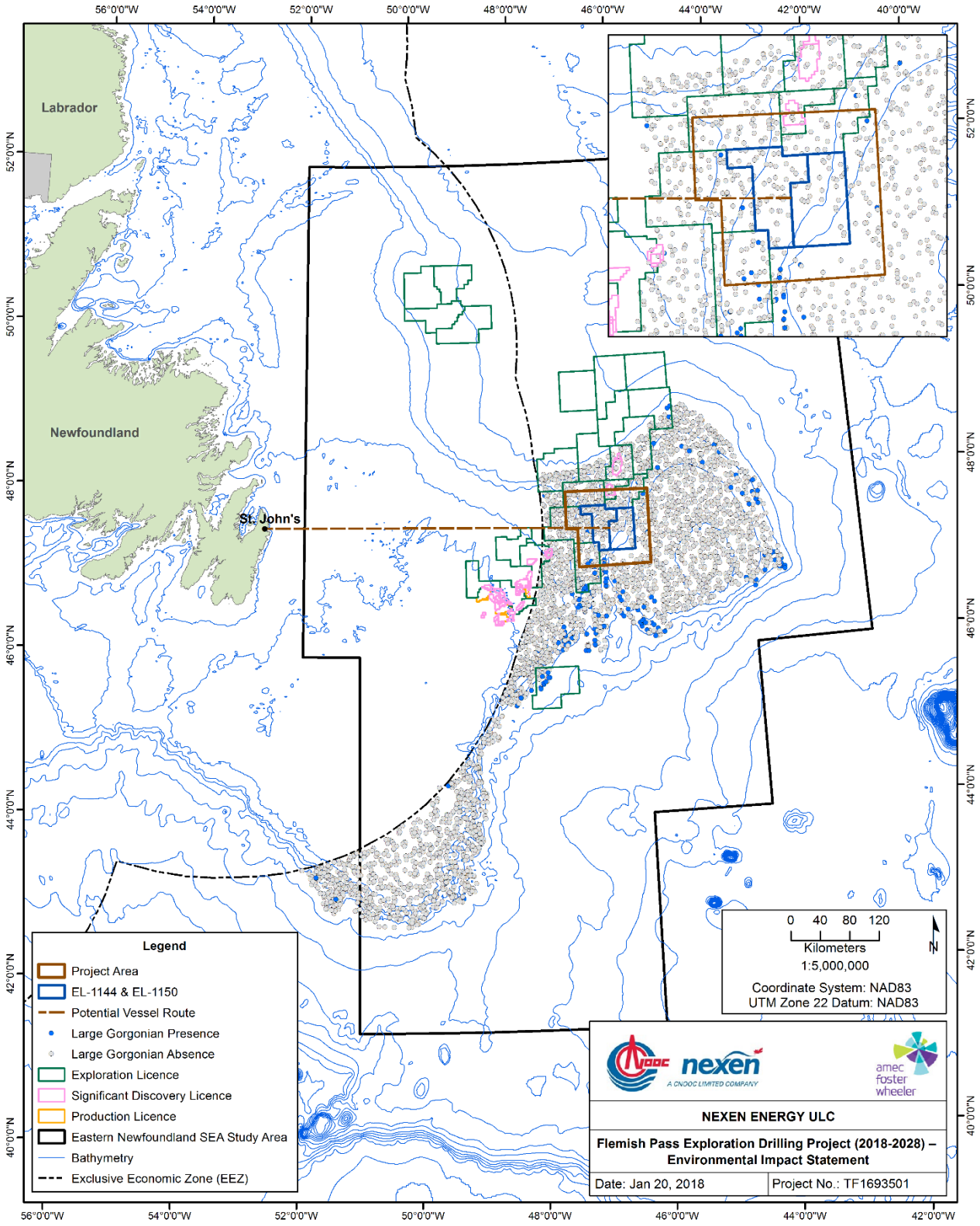


Figure 6.8 Large Gorgonian Coral Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013)



There are also at least 60 sponge species found within the region (Table 6.8) (Murillo et al 2012; Beazley et al 2013a; Knudby et al 2013; Beazley and Kenchington 2015; Beazley et al 2015). Sponges are fragile marine organisms that often disintegrate before reaching the surface for identification and as such many samples are not identified to species in trawl surveys (Knudby et al 2013; Table 6.8). Therefore, sponge diversity may be under represented in published reports (Knudby et al 2013). Sponges exhibit a wide depth range (100-1,500 m) with the highest sponge biomass in northwest portion of the RSA located on the upper slopes of the Flemish Cap (Murillo et al 2012). Canadian RV surveys also indicate high sponge occurrence in the northwestern slope of the Grand Banks in the RSA (Figure 6.9).

Table 6.8 Sponges Occurring within the Project Area and Adjacent Environments

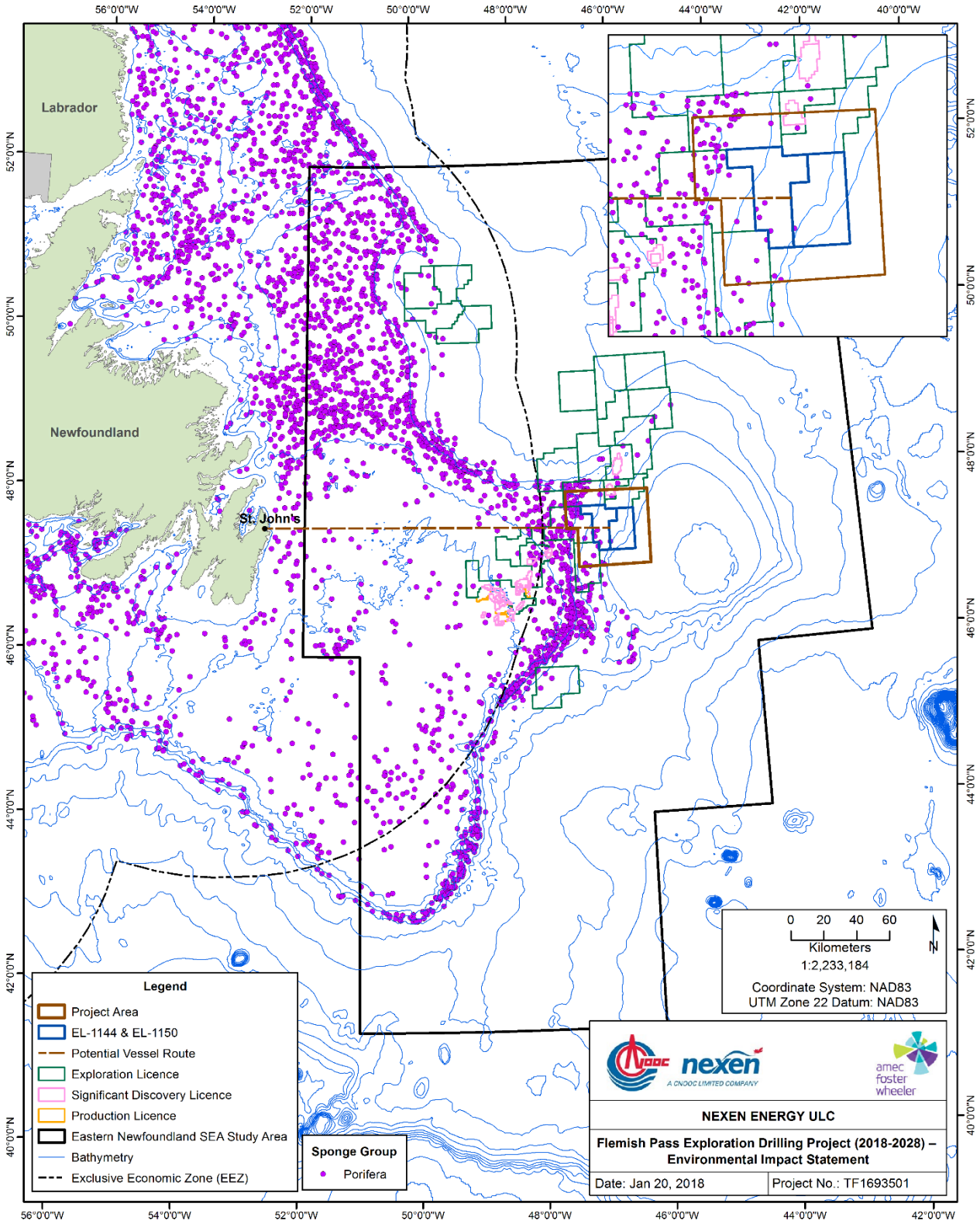
Group	Species	Depth Range (m)	Flemish Cap	Flemish Pass	Reference
Hexactinellida	*Aphrocallistes Beatrix*	404	●		6
	Asconema foliata	138-1,374	●	●	3; 5; 6
	Asconema sp.	-	●		2
	Dictyaulus romani	1,079-1,332	●		6
	Euplectellidae indet.	-	●		5
Demospongiae	Demospongiae indet.	144-163	●	●	5; 6
	Desmacellida indet.	170-1,249	●		6
	Haliclona (*Gellius*) sp.	170-380	●		6
	Paratimea sp.	1079-1094	●		6
	Phakellia	1,216	●		6
	Spongionella pulchella	494-538	●		6
	Tethya aurantium	138-341	●		6
Polymastiida	*Polymastia andrica*	306-1,295	●		6
	Polymastia corticata	1,079	●		6
	Polymastia thielei	527-528	●		6
	Polymastia uberrima	138-666	●		6
	Quasillina richardi	138-759	●		6
	Radiella hemisphaerica	141-494	●		6
Spirophorida	*Craniella* spp.	-	●	●	2; 3
	Craniella cranium	138-1,374	●		5; 6
	Craniella polyura	159-478			6
Astrophorida	*Ancorinidae* indet.	-	●		5
	Stelletta normani	759-1,374	●		5; 6
	Stelletta tuberosa	1079-1332	●		6
	Stryphnus fortis	759-1,374	●		6
	Stryphnus ponderosus	-	●		5
	Geodia barretti	979-1,374	●	●	3; 4; 5; 6
	Geodia macandrewii	874-1,374	●		5; 6

Group	Species	Depth Range (m)	Flemish Cap	Flemish Pass	Reference
	Geodia phlegraei	874-1,374	●		4; 5; 6
	Thenea muricata	567-1,374	●		5; 6
Hadromerida	*Hemiasterellidae* indet.	-	●		5
	Weberella bursa	478-1,370	●		5; 6
	Weberella sp.	-	●		5
	Rhizaniella sp.	452-1,351	●	●	1; 5; 6
	Stylocordyla borealis	335-866		●	1; 6
Poecilosclerida	*Asbestopluma* sp.	-	●		2
	Artemisina arcigera	154-620	●		6
	Chondrocladia sp.	404	●		2; 6
	Iophon piceum	138-1,351	●		5; 6
	Esperiopsis villosa	141-1,290	●		6
	Forcepia sp.	629-1,351	●		5; 6
	Hymedesmiidae sp.	-	●		2
	Crella sp.	119-1,249	●		5; 6
	Mycale lingua	119-1,351	●		5; 6
	Mycale loveni	148-777	●		6
	Myxilla sp.	1,216-1,332	●		5; 6
Halichondrida	*Halichondrida* indet.	-	●		5
	Hymeniacidon sp.	59-1,351	●		5; 6
	Axinella sp.	257-538	●		5; 6
	Axinella sp.	1,079-1,242	●		6

Sources: Based on 1. Beazley et al (2013a); 2. Beazley and Kenchington (2015); 3. Beazley et al (2015); 4. Knudby et al (2013); 5. Murillo et al (2012); 6. Murillo et al (2016)
Listed depth ranges are from Murillo et al (2016) and Buhl-Mortensen et al (2015).

Regionally, areas with relatively high sponge biomass are located in the southern Flemish Pass and eastern slope of the Grand Banks (Murillo et al 2012; Kenchington et al 2013). Within the Project Area itself and adjacent environments, sponge densities are considered low (≤10 kg/km) on the seabed and medium (10-249 kg/km) on the slopes (Kenchington et al 2013). Sponges from the order *Astrophorida,* including *Geodia barreti, Geodia macandrewii, Geodia phlegraei,* were dominant species in terms of sponge biomass (Murillo et al 2012). Food availability and depth are considered to be key predictors of sponge abundance and biomass (Knudby et al 2013; Guijarro et al 2016).

Figure 6.9 Sponge Distribution Based on Canadian RV Surveys (2005-2015)

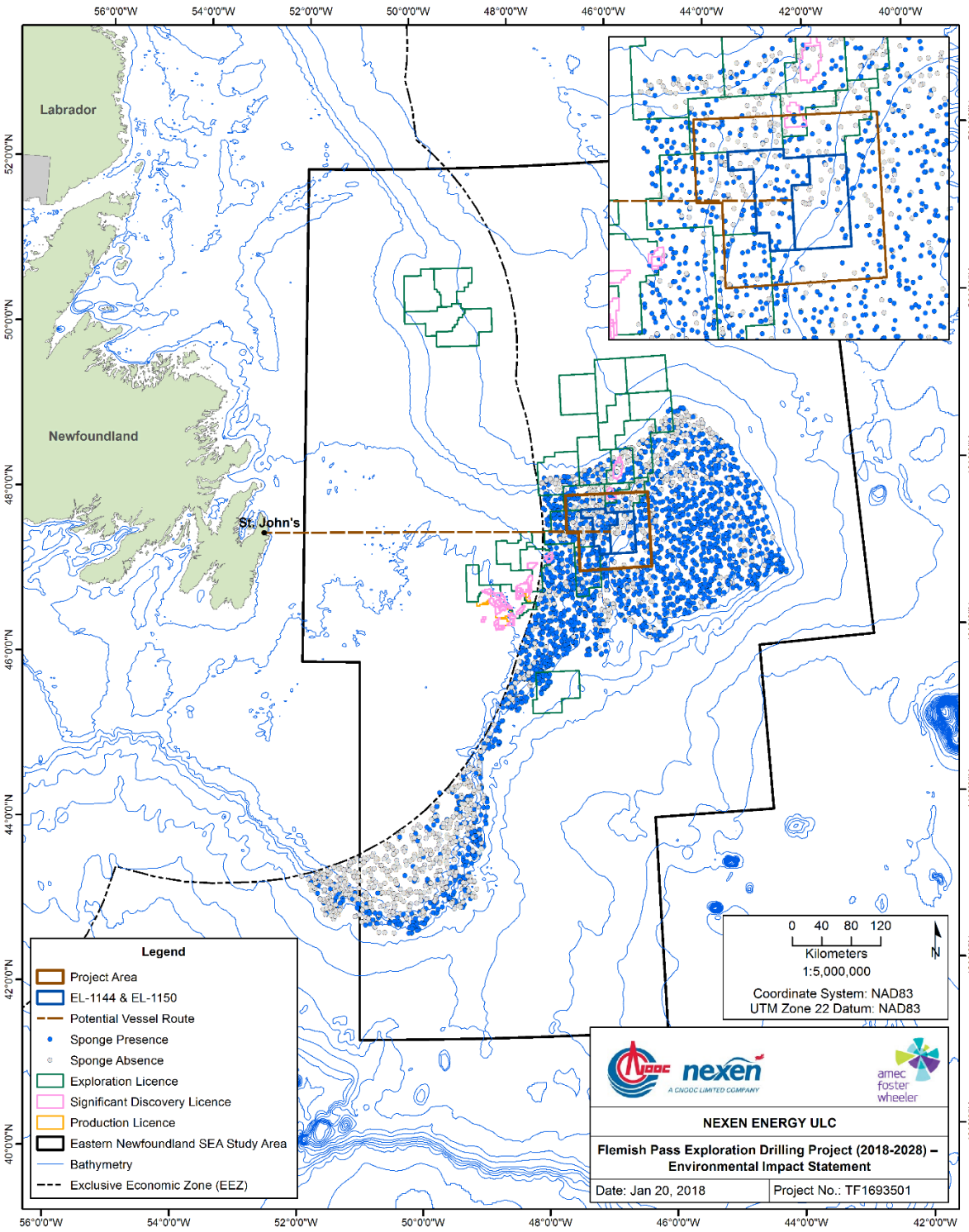


Sponges were well distributed in the Project Area based on EU Spanish Trawl survey data (Table 6.9). Sponges were mainly present on the bottom of the Flemish Pass and on shelf areas in EL 1144 and in the remainder of the Project Area (Figure 6.10). Sponges were present in 68.4 percent and 73.5 percent of trawls in EL 1144 and the remainder of the Project Area, respectively. Sponges were also dispersed on the slope, but to a lesser extent. There were fewer observations in EL 1150 where they were present in 46.4 percent of trawls. Although sponges were not consistently identified to species, species were primarily from the families *Geodiidae* and *Ancorinidae* (Kenchington et al 2014; Murillo et al 2012).

Table 6.9 Sponge Percent Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013)

Species	EL 1144 600-1,300 m (49)		EL 1150 250-1,300m (28)		Remainder of Project Area 250-1,300 m (209)	
	No of Trawl Species present	% of Trawls Species Present	No of Trawl Species present	% of Trawls Species Present	No of Trawl Species present	% of Trawls Species Present
Sponge	36	73.5	13	46.4	143	68.4
Number of total trawls noted in brackets. Adapted from Kenchington et al (2014b)						

Figure 6.10 Sponge Presence in Trawls in the Project Area based on EU Spanish Surveys (2004-2013)



The Tables above provide an overview of the various coral, and sponge species found off Eastern Newfoundland that may potentially occur in the Project Area and their known regional depth range. Table 6.10 below provides a summary of the known and potential presence of these species within the Project Area itself based on existing and available information sources (Beazley et al 2013, Knudby et al 2013; Guijarro et al 2016; Murillo et al 2016).

Table 6.10 Known and Potential Presence of Corals and Sponges in the Project Area

Project Area Component	Known Species Presence and Distribution Based on Existing Data	Potential Species Presence and Distribution Based on Key Habitat Parameters

EL 1144	Sponges (Beazley et al 2013a, Knudby et al 2013)
	• Hexactinellida
	  o *Asconema sp.*
	• Demospongiae
	  o *Axinellidae spp.*
	  o *Geodia sp.*
	  o *Polymastiidae sp*.
		Occurrence records indicate sponges are concentrated along the slopes of Newfoundland and Labrador (Guijarro et al 2016). Sponge species are distributed at species specific depths along the slope areas. Distributional modelling indicates:
		• Fall primary production average maximum as top predictor for sponge (multiple species) presence-absence (Guijarro et al 2016).
		• Summer primary production average minimum as top predictor for sponge (multiple species) biomass (Guijarro et al 2016).
		Geodia species generally at depths >500m in areas of high maximum bottom current (>0.1 m/s) and minimum salinity (>34.4 psu) (Knudby et al 2013).

	Corals (Canadian RV Data)
	• Gorgonian
	  o *Radicipes gracilis*
	• Sea pen
	  o *Anthoptilum grandiflorum*
	  o *Funiculinia quandrangularis*
	  o *Halipteris finmarchica*
	  o *Pennatula aculeata*
	  o *Pennatula phosphorea*
	  o *Pennatula grandis*
	  o *Pennatula sp*.
	  o Sea pen sp.
	• Soft coral
	  o *Anthomastus sp.*
	  o *Duva florida*
		Occurrence records indicate sea pens and gorgonian corals are concentrated along the slopes of Newfoundland and Labrador (Guijarro et al 2016). Coral species are distributed at species specific depths along the slope areas.
		
		Distributional modelling indicates:
		• Depth as top predictor for sea pens, and gorgonian corals presence-absence (Guijarro et al 2016).
		• Maximum average winter mixed layer depth as top predictor for sea pen biomass (Guijarro et al 2016).
		• Summer primary production average minimum as top predictor for large gorgonian coral biomass (Guijarro et al 2016).
		• Average minimum fall *chlorophyll a* range as top predictor for small gorgonian coral biomass (Guijarro et al 2016).

Project Area Component	Known Species Presence and Distribution Based on Existing Data	Potential Species Presence and Distribution Based on Key Habitat Parameters

EL 1150	Sponges (Beazley et al 2013a, Knudby et al 2013)
	• Hexactinellida
	  ○ *Asconema* sp.
	• Demospongiae
	  ○ *Axinellidae* spp.
	  ○ *Geodia* sp.
	  ○ *Polymastiidae* sp.
		Occurrence records indicate sponges are concentrated along the slopes of Newfoundland and Labrador (Guijarro et al 2016). Sponge species are distributed at species specific depths along the slope areas.
		
		Distributional modelling indicates:
		• Fall primary production average maximum as to predictor for sponge (multiple species) presence-absence (Guijarro et al 2016).
		• Summer primary production average minimum as to predictor for sponge (multiple species) biomass (Guijarro et al 2016).
		Geodia species generally at depths >500m in areas of high maximum bottom current (>0.1 m/s) and minimum salinity (>34.4 psu) (Knudby et al 2013).

	Corals (Canadian RV Data, Murillo et al 2016)
	• Black-wire Coral
	  ○ *Stauropathes arctica*
	  ○ *Stauropathes cf. arctica*
	• Gorgonian
	  ○ *Acanella arbuscula*
	• Sea Pen
	  ○ *Anthoptilum grandiflorum*
	  ○ *Funiculinia quandrangularis*
	  ○ *Halipteris finmarchica*
	  ○ *Pennatula grandis*
	  ○ *Pennatula* sp.
	  ○ Sea pen sp.
	  ○ *Umbellula* sp.
	• Soft Coral
	  ○ *Anthomastus* sp.
	  ○ *Duva florida*
	  ○ Nephtheidae sp.
	  ○ *Heteropolypus sol*
	• Stony Coral (solitary)
	  ○ *Flabellum alabastrum*
		Occurrence records indicate sea pens and gorgonian corals are concentrated along the slopes of Newfoundland and Labrador (Guijarro et al 2016). Coral species are distributed at species specific depths along the slope areas.
		
		Distributional modelling indicates:
		• Depth as top predictor for sea pens, and gorgonian corals presence-absence (Guijarro et al 2016).
		• Maximum average winter mixed layer depth as top predictor for sea pen biomass (Guijarro et al 2016).
		• Summer primary production average minimum as top predictor for large gorgonian coral biomass (Guijarro et al 2016).
		• Average minimum fall chlorophyll a range as top predictor for small gorgonian coral biomass (Guijarro et al 2016).*Stauropathes artica* (black-wire coral), *Flabellum alabastrum* (solitary cup coral), *Funiculina quadrangularis* (sea pen), and *Heteropolypus* sol (soft coral), *Acanella arbuscula* (gorgonian coral) characteristic coral species on the Flemish Cap at 500-900 m depths, mainly on sandy-silt bottoms (Murillo et al 2016).

Project Area Component	Known Species Presence and Distribution Based on Existing Data	Potential Species Presence and Distribution Based on Key Habitat Parameters
		Sea pens *Funiculina quadrangularis*, *Anthoptilum grandiflorum*, *Halipteris finmarchica*, *Pennatula aculeata* are characteristic corals of the lower slope of Flemish Cap on Sandy and clay-silt bottoms between 800-1200 m depth (Murillo et al 2016).

Remainder of Project Area	Sponges (Beazley et al 2013a, Knudby et al 2013)
	• Hexactinellida
	  ○ *Asconema* sp.
	• Demospongiae
	  ○ Axinellidae spp.
	  ○ *Geodia* sp.
	  ○ Polymastiidae sp.
		Occurrence records indicate sponges are concentrated along the slopes of Newfoundland and Labrador (Guijarro et al 2016). Sponge species are distributed at species specific depths along the slope areas.
		
		Distributional modelling indicates:
		• Fall primary production average maximum as to predictor for sponge (multiple species) presence-absence (Guijarro et al 2016).
		• Summer primary production average minimum as to predictor for sponge (multiple species) biomass (Guijarro et al 2016).
		Geodia species generally at depths >500m in areas of high maximum bottom current (>0.1 m/s) and minimum salinity (>34.4 psu) (Knudby et al 2013).

	Corals (Canadian RV Data)
	• Black-wire coral
	  ○ *Antipatharian* sp.
	  ○ *Stauropathes arctica*
	• Gorgonian
	  ○ *Acanella arbuscula*
	  ○ *Acanthogorgia armata*
	  ○ *Paragorgia arborea*
	  ○ *Paramuricea placomus*
	• Sea Pen
	  ○ *Anthoptilum grandiflorum*
	  ○ *Distichoptilum gracile*
	  ○ *Funiculinia quandrangularis*
	  ○ *Halipteris finmarchica*
	  ○ *Pennatula aculeata*
	  ○ *Pennatula grandis*
	  ○ *Pennatula* sp.
	  ○ Sea pen sp.
	  ○ *Umbellula* sp.
	• Soft Coral
	  ○ *Anthomastus* sp.
	  ○ *Drifa cf. glomerata*
		Occurrence records indicate sea pens and gorgonian corals are concentrated along the slopes of Newfoundland and Labrador (Guijarro et al 2016). Coral species are distributed at species specific depths along the slope areas.
		
		Distributional modelling indicates:
		• Depth as top predictor for sea pens, and gorgonian corals presence-absence (Guijarro et al 2016).
		• Maximum average winter mixed layer depth as top predictor for sea pen biomass (Guijarro et al 2016).
		• Summer primary production average minimum as top predictor for large gorgonian coral biomass (Guijarro et al 2016).
		• Average minimum fall *chlorophyll a* range as top predictor for small gorgonian coral biomass (Guijarro et al 2016).

Project Area Component	Known Species Presence and Distribution Based on Existing Data	Potential Species Presence and Distribution Based on Key Habitat Parameters
	○ *Drifa* sp. ○ *Duva florida* ○ *Gersemia* sp. ○ Nephtheidae sp. • Stony Coral (solitary) ○ *Flabellum alabastrum*	

6.1.6.6 Invertebrate Reproduction

Marine invertebrates use a variety of reproduction strategies, often in response to environmental parameters. Environmental cues that trigger reproduction include changing photoperiod, temperature (Sun et al 2010), lunar cycles (Mercier and Hamel 2010; 2014), and inter and intra-species biochemical cues (Hamel and Mercier 1999; Soong et al 2005). Seasonal spawning and or release of larvae is generally associated with elevated food levels in the water column during spring (April to June) and fall (September to November) phytoplankton blooms (Maillet et al 2004). Identifying key spawning periods is, however, somewhat confounded by variations in reproduction cycles that can occur across spatial and depth scales within species (Kelly et al 2000; Mercier and Hamel 2010; Baillon et al 2011). Furthermore, aseasonal spawning and multi-year reproduction cycles have been reported. Determining reproduction characteristics in deep sea invertebrates is also challenging due to limitations in research sample collection (Baillon et al 2011) that may affect assessments of maturity, fecundity, sex ratios, spawning cycles and spawning strategies.

Reproductive cycles have been studied in some coral species collected from the Grand Banks and the Flemish Cap that occur within the RSA. *Drifa glomerata*, a soft coral, has exhibited larval production year-round in the laboratory. However, a seasonal larval release also occurred from December to January associated with increasing photoperiod and maximum temperatures at 150 m depth, and in April to June associated with the spring phytoplankton bloom (Sun et al 2010). A similar seasonal spawning from April to June occurred in the soft coral *Gersemia fruticosa and the sea pen Anthoptilum grandiflorum* and was in relation to the spring phytoplankton bloom (Sun et al 2011; Baillon et al 2014b). The large gorgonian coral, *Primnoa resaeformis*, is a broadcast spawner with a reproductive cycle that varies across depths and location (Mercier and Hamel 2011). Mercier and Hamel (2011) suggest that the lack of seasonal spawning indicates that their reproductive cycle may spawn across years and is consistent with slow growing and long lived deep sea species. The broadcast spawning gorgonian *Keratoisis ornata*, and the brooding soft coral *Anthomastus grandifloras*, exhibit seasonal spawning from July to September and October to November respectively that were associated with seasonal warm seawater temperatures and high rates of detritus deposition. The temporal differences in spawning between these two species may be due to the lag in detritus deposition at greater depths (Mercier and Hamel 2010).

Available food levels have also been associated with triggering reproductive cycles in the sponge *Geodia barretti* collected from 80-200 m. Only sexual reproduction has been observed in this species from studies in the northeast Atlantic with spawning coinciding with spring and autumn phytoplankton blooms (Spetland et al 2007). A secondary spawning in this species was only associated with one of the study areas, indicating spatial differences in reproductive cycles within the same species.

Areas for invertebrate spawning and larval settling are generally areas of high densities of invertebrates, corals and sponges as many marine benthic invertebrates have low mobility and require particular proximity among individuals for reproduction. Living and deceased corals and sponges add habitat complexity to areas and act as larval settling areas and nurseries for a variety of fish and invertebrate species. Areas of high invertebrate densities have been identified through current and proposed vulnerable marine ecosystems (VMEs) and ecologically and biologically significant areas (EBSAs) along the northeast shelf and slope of the Grand Bank, the Flemish Cap, and southern Flemish Pass (see Section 6.4 for further details).

6.1.7 Finfish

Marine fish in the Project Area and larger RSA collectively exhibit a broad range of ecological roles, habitat requirements and morphologies and range from small planktivorous fish to large predatory sharks. The ecological roles of these species change over their life history, often beginning as eggs and larvae in the planktonic community and changing diets and habitats as they mature. Aside from their inherent ecological importance, species in this group are further recognized for their commercial, and cultural importance.

General information describing marine fish species known to inhabit the region has previously been described in the Eastern Newfoundland SEA (Amec 2014, see Section 4.2.1). The sections that follow identify and describe key demersal and pelagic marine fish species that occur in the Project Area and RSA, and describe species assemblages associated with particular depth zones. While fish are mobile, oceanographic conditions and features may result in “boundaries” to migration for some species. For example, the anti-cyclonic gyre on the Flemish Cap results in high larval retention within that area and the large depths of the Flemish Pass also acts as a barrier to migration between the Newfoundland Shelf and Flemish Cap for many groundfish species (Pérez-Rodríguez et al 2012, 2016). Fish assemblages have also been tied to depth zones and the associated environmental parameters within those zones (Gomes et al 1992; Nogueira et al 2017).

As there are no comprehensive data sets for the entire RSA, data from the Canadian RV surveys were used to establish marine fish assemblages for areas 250-1,300 m depth within the 200 nautical mile EEZ. Fish species associated with the Flemish Cap and the Flemish Pass were determined from representative studies (Murua and Cardenas 2005; Vázquez et al 2013; Nogueira et al 2017) that sampled within and outside the Project Area.

6.1.7.1 Grand Banks Shelf and Flemish Pass

The Canadian RV survey includes areas of the Grand Banks shelf and slope and the Flemish Pass. Fish catches in and around the Project Area were highest in the shallow slope zone where lanternfish were the dominant species captured in Canadian RV surveys (Table 6.11). Lanternfish also dominated catches in the middle slope (600-1,000 m) but had relatively low abundance. In the deep slopes of the Project Area, roundnose grenadier was the dominant species, although lanternfish was a key species at this depth zone. Overall species abundance declined with depth, however species diversity increased with depth. At shallower depths, the areas are often dominated by a few species with high abundance, and the trend is similar to other areas in the region (Nogueira et al 2017).

Table 6.11 Summary of Depth Categories used to Present Canadian RV Survey Data (2008-2012)

Depth Zone	Proportion of Survey Area (%)	No. of Species to make up 95% of Catch	Dominant Fish Species (% of Catch)	Dominant Fish Species CPUE (Mean Abundance / Tow)	Dominant Fish Species Catch	Total Fish Species Catch
Shallow Slope (250-600 m)	37.2	8	Lanternfish (62.5%)	371.6	12,633	20,219
Middle Slope (600-1,000 m)	22.3	9	Lanternfish (48.3%)	108.1	3,674	7,612
Transition Slope (1,000-1,300 m)	40.5	10	Roundnose grenadier (30.6%)	23.0	780	2,553

Similar fish species are captured across shallow to transition slope depth zones (250-1,300 m). Lanternfish, common grenadier, roughhead grenadier, longnose eel, and Greenland halibut were dominant species for the area as they have a wide depth range and were present across all depths (Table 6.12). Species associated with relatively shallow shelf and slope areas include deepwater redfish and barracudina that were captured at less than 1,000 m. Blue hake and roundnose grenadier were associated with deeper habitats as they were key species in depth zones below 600 m. At higher depths, species abundances are more similar than at shallower depths, increasing the species diversity required to account for 95 percent of individuals captured. Other species identified that contributed to species assemblages included white hake at shallow slopes, and dragonfish, viper fish and blacksmelts at the transition slope, which were specific to a particular depth zone and had relatively low contribution to the overall assemblage.

Table 6.12 Numerically Dominant Fish Species (95% of Overall Abundance) within the Project Area inside the EEZ by Depth Zone (Canadian RV Surveys, 2008-2012)

Depth Zone	Common Name	Scientific Name	Mean Abundance / Tow (n=34)	Total Abundance	Contribution to Survey (%)	Cumulative (%)
Shallow Slope (250-600 m)	Lanternfish	Myctophidae (F)	371.6	12633.0	62.5	62.5
	Deepwater redfish	*Sebastes mentella*	113.9	3871.2	19.1	81.6
	Common grenadier	*Nezumia bairdii*	24.7	840.6	4.2	85.8
	Longnose eel	*Synaphobranchus kaupii*	24.1	820.3	4.1	89.8
	Barracudina	Paralepididae (F)	9.7	331.5	1.6	91.5
	Roughhead grenadier	*Macrourus berglax*	8.0	271.8	1.3	92.8
	Greenland halibut	*Reinhardtius hippoglossoides*	7.7	262.4	1.3	94.1
	White hake	*Urophycis tenuis*	7.2	243.7	1.2	95.3

Depth Zone	Common Name	Scientific Name	Mean Abundance / Tow (n=34)	Total Abundance	Contribution to Survey (%)	Cumulative (%)
Middle Slope (600-1000 m)	Lanternfish	Myctophidae (F)	108.1	3674.2	48.3	48.3
	Longnose eel	*Synaphobranchus kaupii*	36.5	1241.9	16.3	64.6
	Blue hake	*Antimora rostrata*	20.1	683.7	9.0	73.6
	Common grenadier	*Nezumia bairdii*	15.1	513.4	6.7	80.3
	Roundnose grenadier	*Coryphaenoides rupestris*	9.2	313.8	4.1	84.4
	Deepwater redfish	*Sebastes mentella*	9.0	306.0	4.0	88.4
	Greenland halibut	*Reinhardtius hippoglossoides*	6.9	235.9	3.1	91.5
	Roughhead grenadier	*Macrourus berglax*	5.6	189.2	2.5	94.0
	Barracudina	Paralepididae (F)	3.2	109.3	1.4	95.5
Transition Slope (1,000-1,300)	Roundnose grenadier	*Coryphaenoides rupestris*	23.0	780.4	30.6	30.6
	Longnose eel	*Synaphobranchus kaupii*	13.8	470.0	18.4	49.0
	Blue hake	*Antimora rostrata*	11.8	402.3	15.8	64.7
	Lanternfish	Myctophidae (F)	9.4	321.1	12.6	77.3
	Roughhead grenadier	*Macrourus berglax*	5.9	202.3	7.9	85.2
	Common grenadier	*Nezumia bairdii*	2.9	98.1	3.8	89.1
	Dragonfish	*Stomias boa ferox*	2.0	66.4	2.6	91.7
	Greenland Halibut	*Reinhardtius hippoglossoides*	1.3	45.3	1.8	93.5
	Viperfish	*Chauliodus sloani*	1.0	34.9	1.4	94.8
	Blacksmelts	*Bathylagus* sp.	0.7	25.4	1.0	95.8

Contribution to survey based on percent abundance. Cumulative contribution to the survey is the cumulative percent abundance across species.
Taxonomic group: Family (F)

Murua and de Cardenas (2005) conducted longline fishing surveys along the middle to deep slopes (700-1,599 m) in the Flemish Pass and identified similar species to the Canadian RV surveys and Kenchington et al 2013 (Table 6.13) including roughhead grenadier, blue hake, black dogfish, Greenland halibut and smalleyed rabbitfish. Other species were common in the RV surveys but not in the longline survey, which may be due to the type of fishing method. For example, roundnose grenadier have smaller mouths that may not have allowed them to take the baited hooks in the longline survey (Murua and de Cardenas 2005).

Table 6.13 Numerically Dominant Fish Species (95% of Overall Abundance) in the Flemish Pass Based on Longline Fishing Surveys

Depth	Common Name	Scientific Name	Contribution to Survey (%)	Cumulative (%)
Middle to Deep Slope (700-1599 m)	Roughhead grenadier	*Macrourus berglax*	69.7	69.7
	Blue hake	*Antimora rostrata*	9.0	78.7
	Black dogfish	*Centroscyllium fabricii*	8.2	86.9
	Greenland halibut	*Reinhardtius hippoglossoides*	5.5	92.4
	Smalleyed rabbitfish	*Hydrolagus affinis*	2.9	95.3
Contribution to survey based on percent abundance across nine longline hauls. Cumulative contribution to the survey is the cumulative percent abundance across species. Source: Murua and de Cárdenas (2005)				

Areas of aggregations for particular species may be also associated sponge grounds. Sampling in the Flemish Pass indicated areas of medium sponge catches (10-249 kg/km) were present along the slopes and associated with increased abundance of blue hake, roughhead grenadier, and longnose eel species abundance (Table 6.14). Areas of low sponge catches (less than 10 kg/km) at deeper areas of the Flemish Pass were associated with increased abundance of lanternfish, blue hake, and roughhead grenadier species abundance (Kenchington et al 2013). Areas of high sponge densities (250 kg/km or greater) were observed in the southern Flemish Pass and on the northern slope of the Flemish Cap and were mainly associated with lower densities of characteristic taxa for low and medium density sponge grounds (Kenchington et al 2013).

Table 6.14 Fish Species Associated with Sponge Ground Densities

Sponge Density	Common Name	Scientific Name	Contribution to Similarity (%)	Cumulative (%)
Low Sponge Catch (≤10 kg/km)	Roughhead grenadier	*Macrourus berglax*	22.83	22.83
	Blue hake	*Antimora rostrata*	19.68	42.51
	Greenland halibut	*Reinhardtius hippoglossoides*	14.69	57.2
	Longnose eel	*Synaphobranchus kaupii*	8.68	65.88
	Black dogfish	*Centroscyllium fabricii*	6.5	72.38
	Roundnose grenadier	*Coryphaenoides rupestris*	6.35	78.73
	Common grenadier	*Nezumia bairdii*	5.31	84.04
	Lanternfishes	*Myctophidae*	2.66	86.7
	Largescaled tapirfish	*Notacanthus chemnitzii*	2.34	89.04
	Threebeard rockling	*Gaidropsaurus spp.*	2.1	91.14
Medium Sponge Catch (10.01-249.99 kg/km)	Blue hake	*Antimora rostrata*	24.48	24.48
	Roughhead grenadier	*Macrourus berglax*	23.16	47.64
	Longnose eel	*Synaphobranchus kaupii*	11.29	58.93
	Greenland halibut	*Reinhardtius hippoglossoides*	9.56	68.49

Sponge Density	Common Name	Scientific Name	Contribution to Similarity (%)	Cumulative (%)
	Black dogfish	*Centroscyllium fabricii*	6.84	75.33
	Roundnose grenadier	*Coryphaenoides rupestris*	6.64	81.97
	Deep-sea cat shark	*Apristurus profundorum*	2.93	84.9
	Common grenadier	*Nezumia bairdii*	2.76	87.66
	Threebeard rockling	*Gaidropsaurus* spp.	2.64	90.3
Source: Kenchington et al (2013). Contribution to similarity (%) is based on taxa contributing to the similarity among various sponge density sites.				

6.1.7.2 Flemish Cap

Redfish species were the most dominant fish species present on the Flemish Cap based on EU RV Surveys (Noguiera et al 2017) as they accounted for over 95 percent of individuals captured (Table 6.15). The dominance of redfish species is reflective of the anti-cyclonic gyre that retains fish larvae in the area (Anderson 1984, Dalley and Anderson 1998; Borovkov et al 2007). At shallower depths, all redfish species are well represented, however redfish species composition changes with depth. Golden redfish are mainly restricted to the shallow slope with a depth range of 130-631 m. Acadian redfish and deepwater redfish have a much wider depth range (138-1,218 m) and occupy all depth ranges in the Project Area and beyond, but their relative abundance decreases with depth. At middle slopes, the dominant species that accounted for over 80 percent of captured fish included Greenland halibut, roundnose grenadier, longnose eel, blue hake, common grenadier, and roughhead grenadier. These results are similar to the Canadian RV surveys that identified the same dominant species at the same depth (600-1,000 m) along the slopes of the Grand Banks.

Table 6.15 Abundant Fish by Depth Zone on the Flemish Cap (EU RV Surveys, 2004-2013)

Depth Zone	Common Name	Scientific Name	% Biomass	% Abundance	% Occurrence
Shallow Slope (250-600 m)	Acadian redfish	*Sebastes fasciatus*	38.6	46.3	99.3
	Deepwater redfish	*Sebastes mentella*	27.3	32.5	90.3
	Golden redfish	*Sebastes norvegicus*	23.0	17.9	80.1
	Atlantic cod	*Gadus morhua*	6.5	1.4	63.2
	Greenland halibut	*Reinhardtius hippoglossoides*	1.5	0.4	70.9
	Spotted wolffish	*Anarhichas minor*	0.7	0.1	60.1
	Thorny skate	*Amblyraja radiata*	0.5	0.1	65.6
Middle to Deep Slope (>600 m)	Greenland halibut	*Reinhardtius hippoglossoides*	35.2	20.6	95.5
	Roundnose grenadier	*Coryphaenoides rupestris*	14.0	19.0	99.3
	Longnose eel	*Synaphobranchus kaupii*	12.9	13.2	98.9
	Blue hake	*Antimora rostrata*	9.3	12.1	63.6
	Common Grenadier	*Nezumia bairdii*	9.1	11.8	90.8
	Roughhead grenadier	*Macrourus berglax*	6.2	7.4	91.4

Depth Zone	Common Name	Scientific Name	% Biomass	% Abundance	% Occurrence
	Black dogfish	*Centroscyllium fabricii*	2.4	2.4	22.7
	Demon catshark	*Apristurus* sp.	2.3	0.4	94.9
Source: Nogueira et al (2017). Percent biomass, abundance and occurrence based on 1,699 bottom trawl halls collected from 129-1,460 m.					

As with the areas on the Grand Banks and Flemish Pass, Nogueira et al (2017) noted that there was a decrease in overall abundance with depth but an increase in species diversity with depth on the Flemish Cap. Species abundance is similar across species in the middle to deep slopes (over 600 m), but higher in fewer species in the shallow slope. This is reflective of higher productivity at shallower depths that support increased fish abundance.

6.1.7.3 Key Fish Species Distributions

The most abundant species in the Project Area itself based on Canadian RV surveys and the most abundant representative species for the Flemish Cap (Table 6.16) are described below, and in more detail in the Eastern Newfoundland SEA (Amec 2014). Distribution maps are presented from data available from these surveys where available. Seven species were dominant across both data sets and included deepwater redfish, longnose eel, common grenadier, roundnose grenadier, roughhead grenadier, Greenland halibut and blue hake. Some of these species are also of commercial importance. Some species including redfish, grenadiers, white hake and Atlantic cod, are COSEWIC listed species as identified in Section 6.1.8; however, distribution and biological information for these species is described in this section.

Table 6.16 Key Species within the Project Area based on Canadian RV (2008-2012) and EU RV (2004-2013) Surveys

Survey	Common Name	Scientific Name	Total Catch	Contribution to survey (%)	Cumulative (%)
Canadian RV Survey within Project Area (2008-2012)	Lanternfish	Myctophidae (F)	16,628.4	54.7	54.7
	Deepwater redfish	*Sebastes mentella*	4,177.2	13.7	68.5
	Longnose eel	*Synaphobranchus kaupii*	2,532.2	8.3	76.8
	Common grenadier	*Nezumia bairdii*	1,452.2	4.8	81.6
	Blue hake	*Antimora rostrata*	1,321.7	4.3	85.9
	Roundnose grenadier	*Coryphaenoides rupestris*	1,128.7	3.7	89.7
	Roughhead grenadier	*Macrourus berglax*	663.3	2.2	91.8
	Greenland halibut	*Reinhardtius hippoglossoides*	543.6	1.8	93.6
	Barracudina	Paralepididae (F)	447.1	1.5	95.1
	White hake	*Urophycis tenuis*	294.7	1.0	96.1
EU RV Survey on the Flemish Cap (2004-2013)[1]	Acadian redfish	*Sebastes fasciatus*	1,781,944	34.0	34.0
	Golden redfish	*Sebastes norvegicus*	1,345,832	25.7	59.7
	Deepwater redfish	*Sebastes mentella*	1,043,142	19.9	79.6
	Atlantic cod	*Gadus morhua*	144,426	2.8	82.4
	Blue hake	*Antimora rostrata*	43,607	0.8	83.2
	Roundnose grenadier	*Coryphaenoides rupestris*	39,584	0.8	84.0

Survey	Common Name	Scientific Name	Total Catch	Contribution to survey (%)	Cumulative (%)
	Greenland halibut	*Reinhardtius hippoglossoides*	36,075	0.7	84.7
	Common grenadier	*Nezumia bairdii*	33,362	0.6	85.3
	Longnose eel	*Synaphobranchus kaupii*	27,562	0.5	85.8
	Roughhead grenadier	*Macrourus berglax*	17,631	0.3	86.2
Source: [1]Nogueira et al 2017 Contribution to survey: Reported percentage of total abundance, biomass, or trawl presence in the survey. Taxonomic group: Family (F)					

Lanternfish

Lanternfish are a small, pelagic fish family that are widespread in deep waters and characterized by having light producing organs on their bodies (Scott and Scott 1988). Although this group is comprised of multiple species, the glacier lanternfish has been the predominant species (over 80 percent) in myctophids catches on the Grand Banks (McKelvie 1985). Lanternfish primarily feed on copepods and lesser quantities of amphipods, ostracods, hyperiids and fish eggs (Kawaguchi and Mauchline 1982). These fish serve an important ecological role in the systems they inhabit as prey for commercially valued species such as cod, hake, tunas, salmon and marine mammals (Scott and Scott 1988). This characterization is corroborated by Canadian RV Surveys, which show a near absence in shallow areas on the Grand Banks and the highest abundances at the deep water margins of the surveyed area (particularly in the Flemish Pass; Figure 6.11). This species comprises 54.7 percent of overall fish abundance as reported in the Canadian RV survey, but was not considered a key species in Flemish Cap surveys.

Redfish (Acadian, Deepwater, and Golden)

Three species of redfish were captured within the Project Area, including Acadian, deepwater and golden redfish. In the Canadian RV surveys, deepwater redfish was the dominant redfish species captured and represented 13.7 percent of the total catch (Table 6.16; Figure 6.12). Redfish species were well represented in the EU RV surveys with all three species comprising almost 80 percent of total catches on the Flemish Cap (Table 6.16). Both Acadian and deepwater redfish have wide depth ranges of 138-1,200 m (Nogueira et al 2017) with relatively high abundances beyond shelf depths (over 250 m). Golden redfish has the lowest depth range (130-631 m) of the three species and was another key species in shallow slope assemblages on the Flemish Cap (Nogueira et al 2017). Smaller adult redfish tend to occupy shallower waters and may migrate to deeper waters as they grow (COSEWIC 2010a) Areas of concentration were largely on the slopes of the Grand Banks and the Flemish Cap with infrequent captures in the Flemish Pass (Figures 6.12 to 6.16).

Redfish species are long lived (40-75 years in age) commercially harvested species that are associated with the slopes of the Newfoundland Shelf, the Flemish Pass and Flemish Cap. Redfish engage in nocturnal vertical migrations to feed on zooplankton and fish (Scott and Scott 1988; Templeman 2010) but are not known to undertake the seasonal migrations exhibited by many shelf species. These fish are considered semi-pelagic due to their vertical migrations, although they prefer inhabiting shelf slope and deep channel areas (COSEWIC 2010a). Redfish species use internal fertilization with breeding occurring between September and December (COSEWIC 2010a). The larvae are released during the

spring to early summer and are primarily found in surface waters, though they may be found in the upper 200 m of the water column. The diet of larval redfish includes the eggs of fish and invertebrates and some zooplankton. As they reach juvenile and adult sizes, redfish feed mainly on copepods, euphausiids and fish (COSEWIC 2010a).

The redfish stock in this area are considered to be in poor condition and consequently Acadian and deepwater redfish are listed as Threatened by COSEWIC (2010a). Current threats to this Acadian and deepwater redfish species at risk include by-catch mortality, overfishing, predation by seals and unfavourable environmental conditions for groundfish. To date, no critical habitats have been established for these species, however it has been suggested that habitats made up of anemones and coral beds may be linked to redfish survival (COSEWIC 2010a). The Southwest Shelf Edge and Slope is considered an important spawning area for redfish (Templeman 2007).

Longnose Eel

The longnose eel is distributed in northern and southern parts of the Atlantic Ocean, in the Pacific Ocean and the Gulf of Mexico. This bottom dwelling species is commonly observed on the Grand Banks with a depth range of 240-3,650 m (Scott and Scott 1988, Baker et al 2012). This species is considered deep sea scavengers that also prey on euphausiids, amphipods, fish, mysid shrimp and molluscs (Houston and Haedrich 1986; Jamieson et al 2011). This species is preyed on by roundnose grenadiers (DuBuit 1978). It is the eighth most abundant species caught on the Flemish Cap and is a key species in middle to deep slope assemblages at over 600 m depth (Figure 6.17). In the Canadian RV surveys, it is predominantly captured in deep regions of the Flemish Pass or western slopes of the Flemish Cap.

Grenadier (Common, Roundnose, and Roughhead)

Combined abundances of common, roundnose and roughhead grenadiers comprised less than 10 percent and three percent of the total catch in the Canadian (Figures 6.18 to 6.21) and EU RV surveys respectively (Table 6.16). Roundnose and roughhead grenadiers are listed as “endangered” and “special concern” by COSEWIC respectively (COSEWIC 2007, 2008). Grenadiers are slow growing, deep sea species that are important parts of middle slope to deep slope assemblages (250-1,300 m). Roughhead grenadiers have been captured from 200-2,000 m depths and roundnose grenadier have been captured from 180-2,200 m, but both species are mainly observed at 400-1,200 m depths (COSEWIC 2007, 2008). Common grenadier have been captured from 400-1400 m, but are commonly observed at 500-700 m depth (Snelgove and Haedrich 1986; Jørgensen 1996). These three species have similar distributions in the area with aggregations on the slopes of the Grand Banks and the Flemish Pass based on Canadian RV surveys. The Project Area also overlaps with roughhead grenadier catches on the northeastern side of the Flemish Cap (Alpoim and González Troncoso 2016). On the Flemish Cap, distributions available for roughhead grenadiers indicate that areas of concentration are on the deep slopes with relatively low abundances inside the Project Area (Casas and Gonzáles Troncoso 2015). Distribution of roughhead grenadiers may be patchy on the Flemish Cap with a localized area of aggregation based on EU RV surveys.

Roundnose and roundnose grenadiers spawn throughout the year and produce mesopelagic eggs and juveniles, whereas roughhead grenadiers spawn mainly between the winter to early spring and have pelagic larvae (COSEWIC 2007; 2008). Common grenadiers are estimated to spawning in summer and autumn (Scott and Scott 1988). Roundnose grenadiers are thought to migrate into relatively deeper

waters along the slope in winter and into shallower slope areas in the summer, but large-scale migrations are considered unlikely due to their poor swimming capability (COSEWIC 2008). The population structure of roughhead grenadier populations suggests that overall dispersal and movements of roughhead grenadier are also low (COSEWIC 2007). Critical habitat has not been established for the roundnose grenadier due to lack of information of habitat associations in relation to life history stages (DFO 2010a). No critical habitat been established for roughhead grenadier, however spawning grounds for this species are suggested to lie on the southern and southeastern slopes of the Grand Banks (Scott and Scott 1988; COSEWIC 2007).

Diet and feeding habits of grenadiers are dependent on size as young grenadiers feed on zooplankton and become more piscivorous with age (COSEWIC 2007; 2008). Young roughhead grenadiers will also consume a variety of invertebrates including echinoderms, crustaceans and bivalves (COSEWIC 2007). Adult grenadiers feed on shrimp, small fish including myctophids and squid. (COSEWIC 2007; 2008). They prey on benthic invertebrates and small fish and serve as prey to other piscivorous fish (Scott and Scott 1988).

Blue Hake

Blue hake are associated with mud bottoms on the slope and are distributed from 250 to over 2,000 m depths (Figure 6.22). This species feeds on euphausiids, copepods and amphipods (Houston and Haedrich 1986) and is one of the most abundant fish species at bathyal depths (Kulka et al 2003). They are an important part of deepwater assemblages with peak abundances between 1,300-2,200 m depths (Kulka et al 2003; Murua and de Cardenas 2005). Catches from Canadian RV surveys show high aggregations of blue hake on the northern and western slopes of the Flemish Cap and the northeastern slope of the Newfoundland Shelf. This species comprised less than five percent in the Canadian RV surveys and less than one percent of the EU RV survey catch on the Flemish Cap.

Greenland Halibut

Greenland halibut are a commercially important deepwater flatfish with a wide depth range of less than 2,000 m and peak abundances from 1,300-1,600 m (Murua and de Cardenas 2005). This species spends considerable time feeding pelagically on a variety of fish and invertebrates (Morgan et al 2013), including commercially important Atlantic cod, capelin, redfish, shrimp and squid. It also inhabits progressively deeper waters as they age (Bowering and Chumakov 1989). Greenland halibut contributed less than one percent of fish abundance in both the Canadian and EU RV surveys (Nogueira et al 2017; Table 6.16). However, distribution maps from Canadian RV and EU RV surveys indicated areas of aggregation along the slopes of the Grand Banks and Flemish Cap and within the Flemish Pass (Casas and Gonzáles Troncoso 2015). Greenland halibut are also known to aggregate on the Northeast Shelf and Slope EBSA in the spring for foraging opportunities (Templeman 2007) (Figures 6.23 to 6.24). Morgan (2016) indicates that Greenland halibut populations in NAFO areas 2J3K have been increasing in abundance in recent years but populations in 3LNO have been declining.

Barracudina

Barracudinas, including white barracudina and duckbill barracudina, are mesopelagic species that occur on both sides of the North Atlantic (Scott and Scott 1988). These carnivorous fishes feed mainly upon small fish and shrimp and are considered prey for Atlantic cod, Greenland cod, pollock, redfish,

swordfish, and seals (Scott and Scott 1988). Barracudinas were key species in Canadian RV surveys at shallow to middle slopes (250-1,000 m) with concentrations on the Grand Banks slopes (Scott and Scott 1988; Figure 6.25. This species comprised 1.5 percent of the total catch in Canadian RV surveys, but was not a key species in EU RV surveys.

White Hake

White hake are mainly distributed in the Gulf of St. Lawrence, Scotian Shelf, and Southern Newfoundland and is listed as “threatened under COSEWIC 2013 ; DFO 2016a). The population is divided into two DUs; the southern Gulf of St. Lawrence (DU1) and the Atlantic and northern Gulf of St. Lawrence (DU2) (COSEWIC 2013). Since before the mid-1990s and over the past three generations, adult white hake abundance has declined 70 percent in DU2 (DFO 2016a). Fishing mortality through directed fishery and by-catch, remains the greatest threat to white hake populations with habitats considered not likely to be a limiting factor to this species survival and recovery (COSEWIC 2013; DFO 2016a). This species comprised one percent of the total catch in Canadian RV surveys, but was not a key species in EU RV surveys.

White hake are mainly distributed in areas of fine mud substrates at depths of 50-360 m and are listed as “threatened” by COSEWIC (COSEWIC 2013). This coincides with Canadian RV surveys that indicate that white hake are associated with the shallow slope (250-600 m) depth zone and have relatively low abundances in the region (Figure 6.26). White hake were not associated with assemblages on the Flemish Cap (Nogueira et al 2017) and areas of aggregation are largely outside of the Project Area. No critical habitat has been established for this species, however white hake have been observed to aggregate for foraging opportunities in the spring in the Laurentian Channel and Southwest Shelf Edge and Slope EBSAs (Templeman 2007; COSEWIC 2013; DFO 2016a).

This species does not undergo vertical migrations and abundance at depths is linked to fish size as larger adult fish are associated with deeper waters (COSEWIC 2013). Spawning seasons are variable depending on population location with spawning occurring between June to September in the Southern Gulf of St. Lawrence. In offshore areas, spawning is estimated to occur in the spring and in the summer on the Scotian Shelf (COSEWIC 2013). Eggs, larvae and pelagic juveniles may remain planktonic for two to three months depending on environmental conditions and distance to suitable settling areas (COSEWIC 2013). Juvenile and adult hake primarily feed on crustaceans and fish and are prey species for other fish, seabirds, and seals (COSEWIC 2013).

Atlantic Cod

Atlantic cod inhabit coastal and offshore regions from shallow waters to depths of approximately 460 m (Scott and Scott 1988) and are listed as endangered under COSEWIC. This species comprised 2.8 percent of the EU RV survey catch, but was not a key species in Canadian RV surveys for the Project Area. Atlantic cod is an iconic species that dominated the groundfish fishery for centuries and has long been associated commercially and culturally with Newfoundland (COSEWIC 2010b). However, poor environmental conditions and excessive fishing caused the collapse of the stock and resulted in significant and broad socioeconomic and ecological consequences (Worm and Myers 2003; Dawe et al 2012). The stock in this area remains a small percentage (less than three percent) of historical levels and is listed as endangered by COSEWIC (COSEWIC 2010b). Cod are showing signs of recovery after

two decades of restricted fishing (Koen-Alonso et al 2010; Nogueira et al 2014). Currently the main threats to this species include overfishing and by-catch mortality (COSEWIC 2010b).

Atlantic cod have pelagic eggs that are prevalent in the water column from April to November (Knutsen et al 2009; COSEWIC 2010b). Juvenile cod settle to the bottom for the first 1-4 years of life and prefer areas with habitat complexity that help reduce predation risk. Larval cod feed primarily on zooplankton and switch to larger prey including crustaceans, shrimp as they grow. Adult Atlantic cod consume a variety of benthic and pelagic fish and invertebrates including capelin, sand lance, redfish, squid, crab, shrimp, whelks, and polychaetes (COSEWIC 2010b). Adult cod undergo extensive migrations as they travel from offshore to inshore areas in the spring to feed on capelin before returning in the fall (COSEWIC 2010b).

Adult cod occupy a diverse range of habitats and do not have particular depth or bottom substrate preferences though are generally observed at less than 500 m depths in offshore waters. Areas of high cod aggregation are present on the Newfoundland Shelf (Figure 6.27). While Atlantic cod are an important species on the Flemish Cap, their areas of aggregation are mainly restricted to shallow waters (less than 250 m) and are largely outside the Project Area (Figure 6.28; Nogueira et al 2014, 2017). Currently no critical habitat has been established for Atlantic cod, however the Southeast Shoal and Tail of the Banks, Virgin Rocks, Burgeo Banks EBSAs are considered important spawning areas for cod (Templeman 2007).

Figure 6.11 Distribution of Lanternfish (Canadian RV Surveys, 2008-2012)

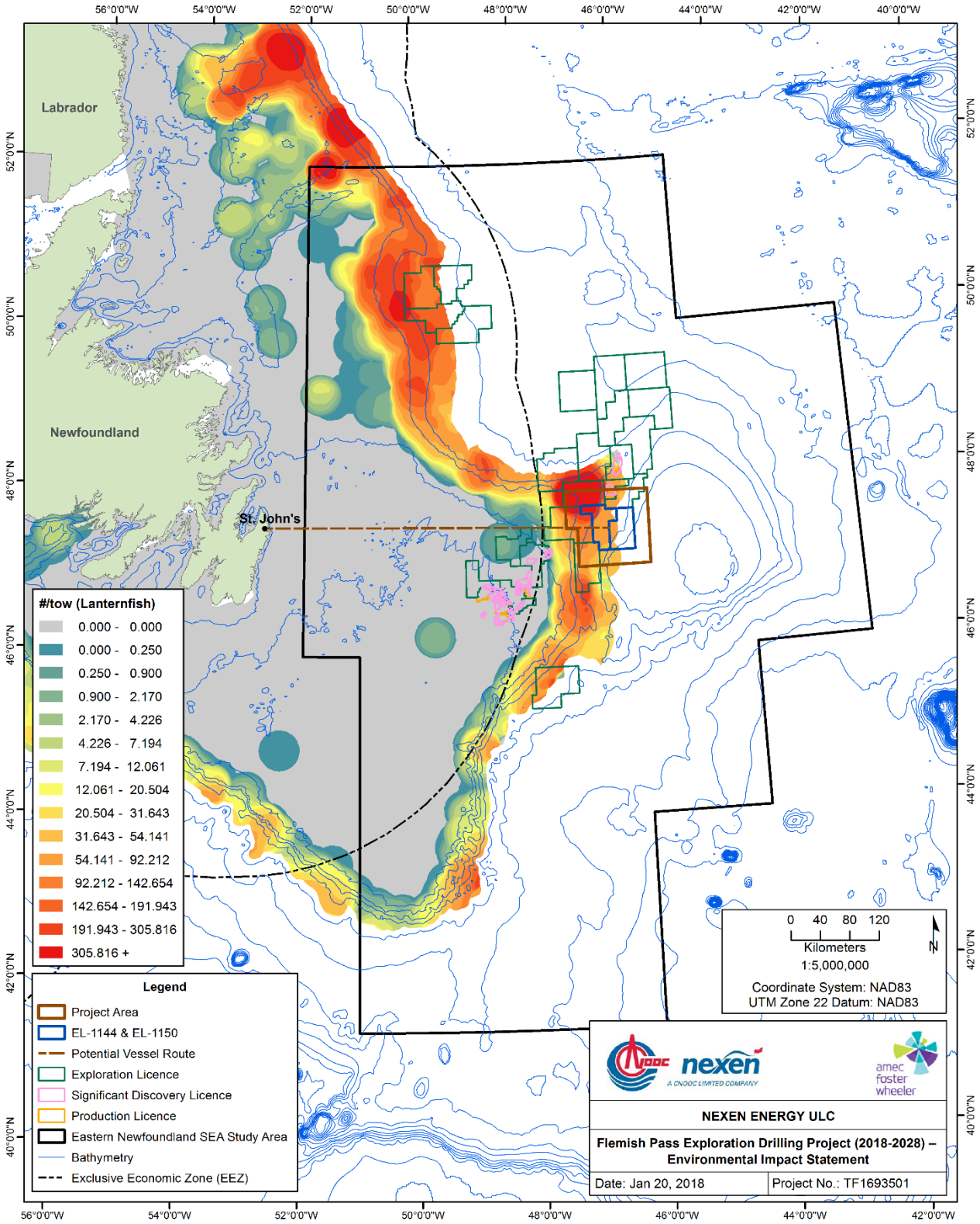


Figure 6.12 Distribution of Acadian and Deepwater Redfish Based on Canadian RV Surveys (2008-2012)

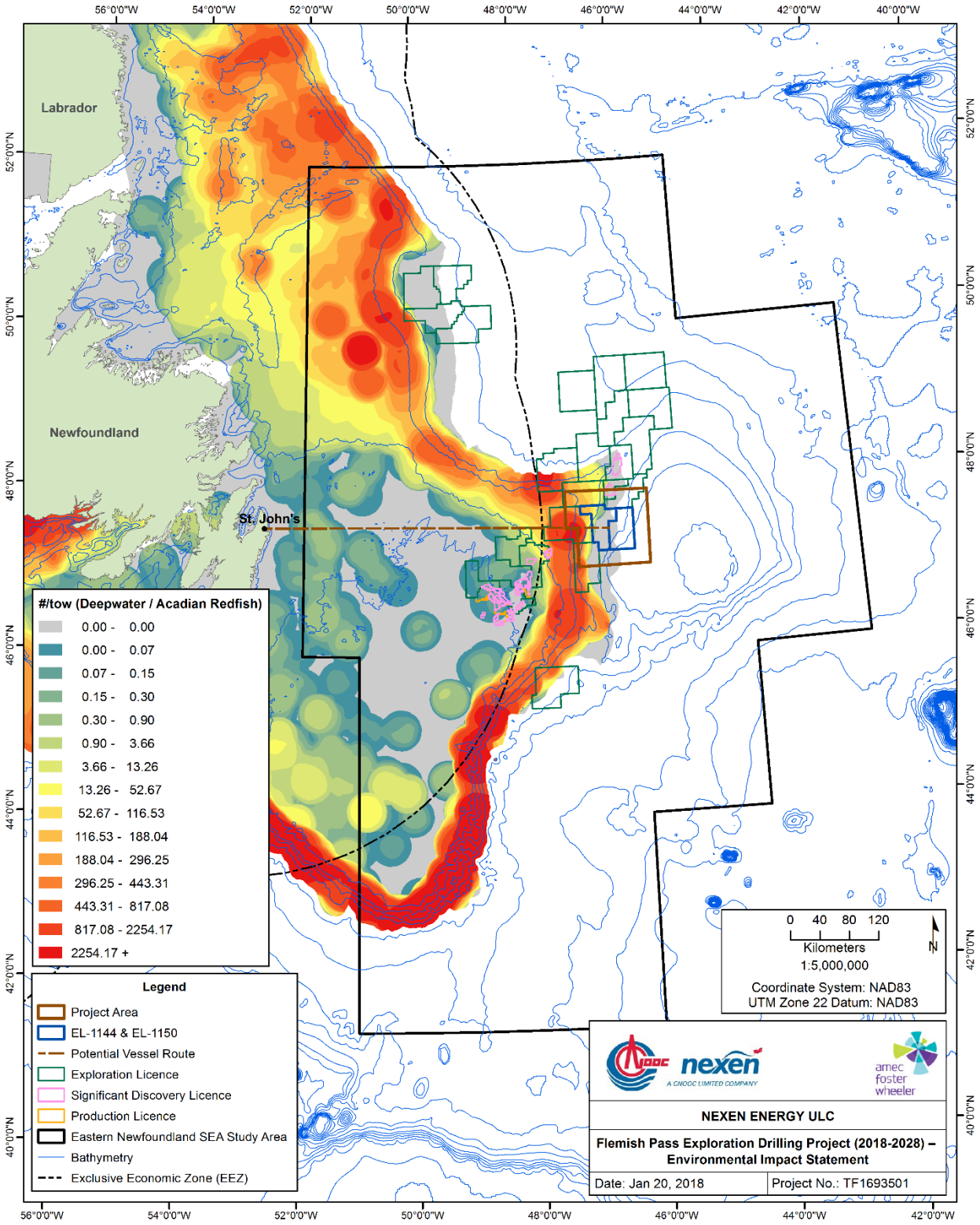


Figure 6.13 Distribution of Deepwater Redfish Based on Flemish Cap EU RV Surveys (2012-2015)

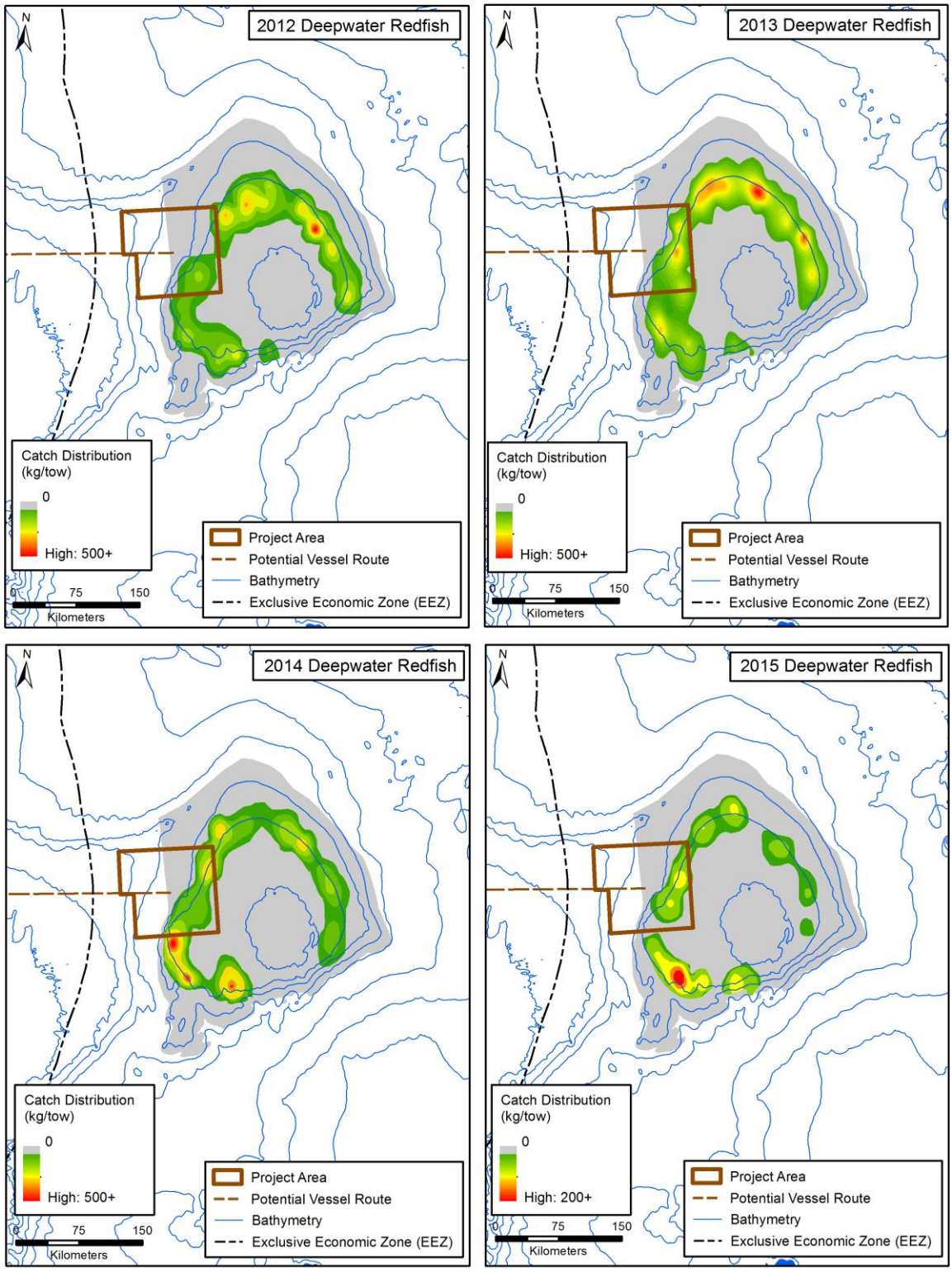


Figure 6.14 Distribution of Golden Redfish Based on Canadian RV Surveys (2008-2012)

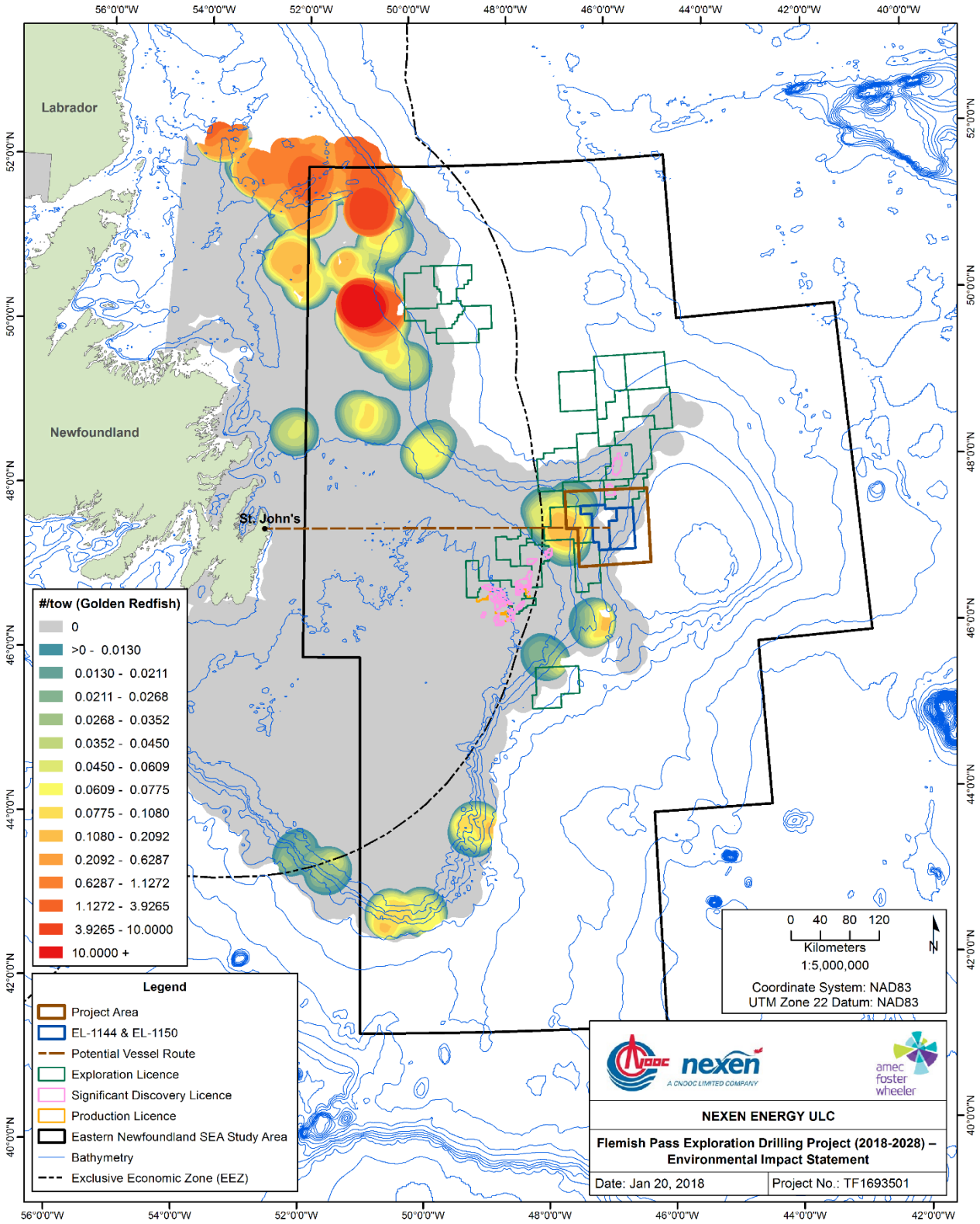


Figure 6.15 Distribution of Golden Redfish Based on Flemish Cap EU RV Surveys (2012-2015)

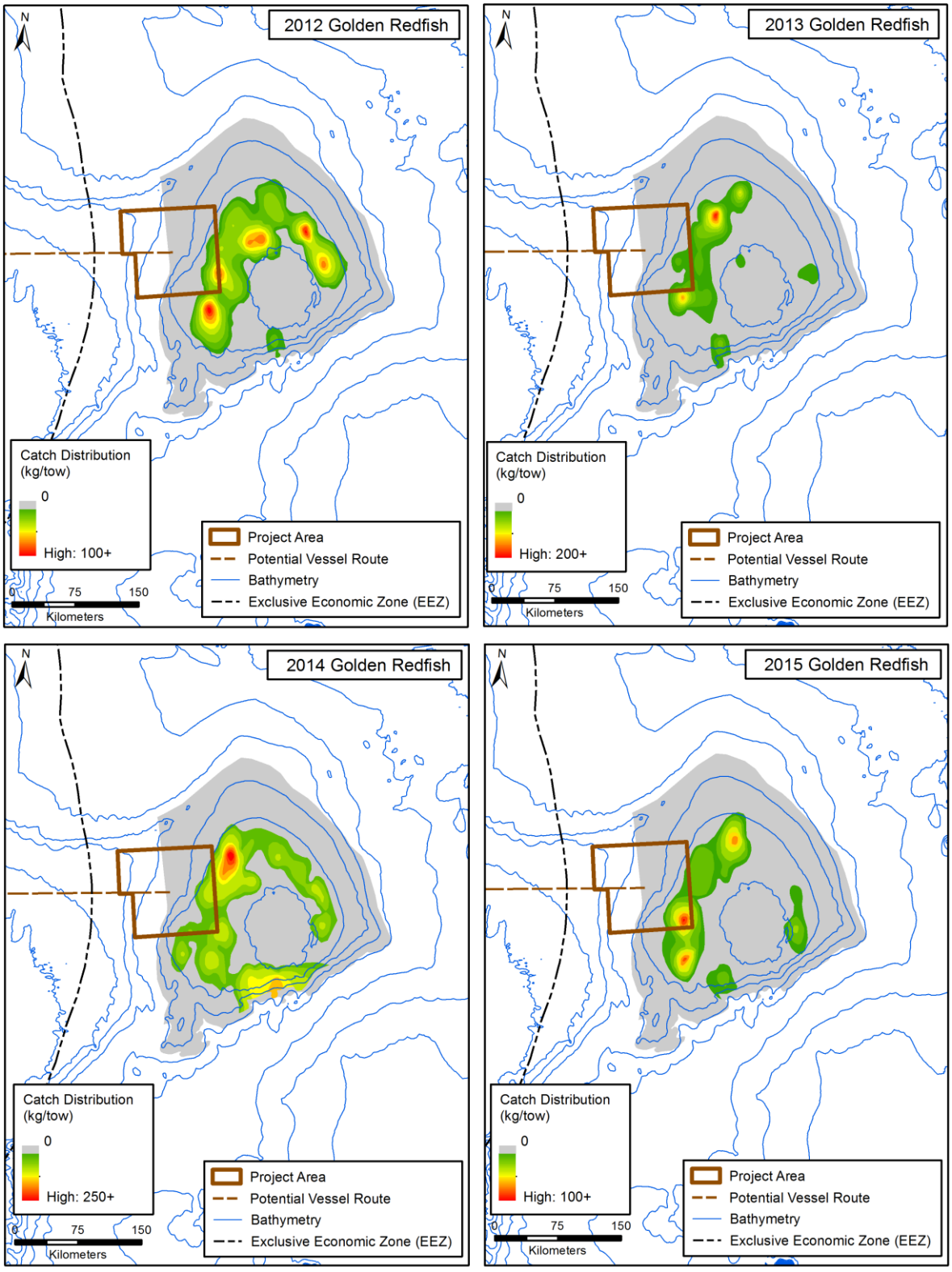


Figure 6.16 Distribution of Acadian Redfish Based on Flemish Cap EU RV Surveys (2012-2015)

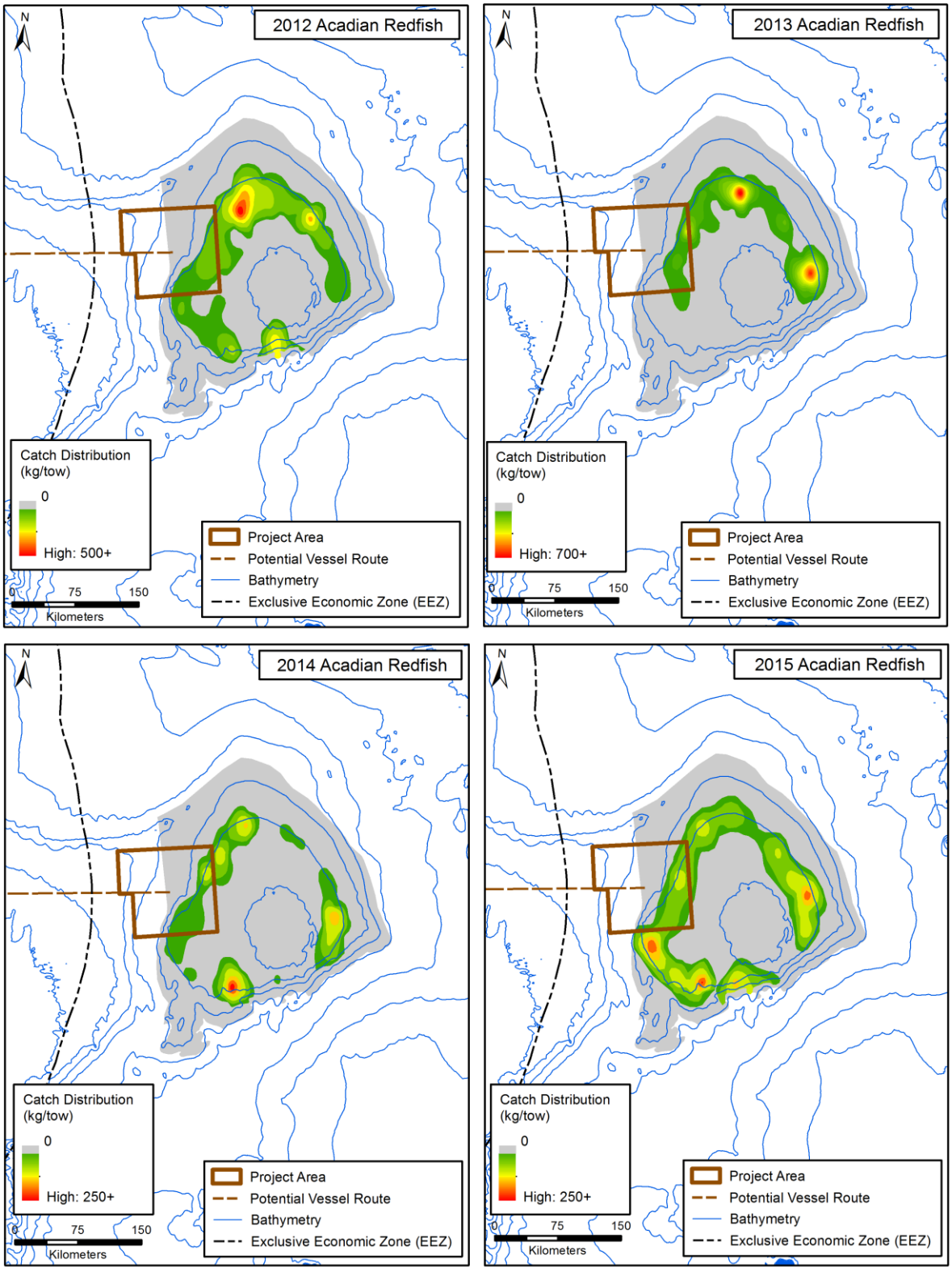


Figure 6.17 Distribution of Longnose Eel Based on Canadian RV Surveys (2008-2012)

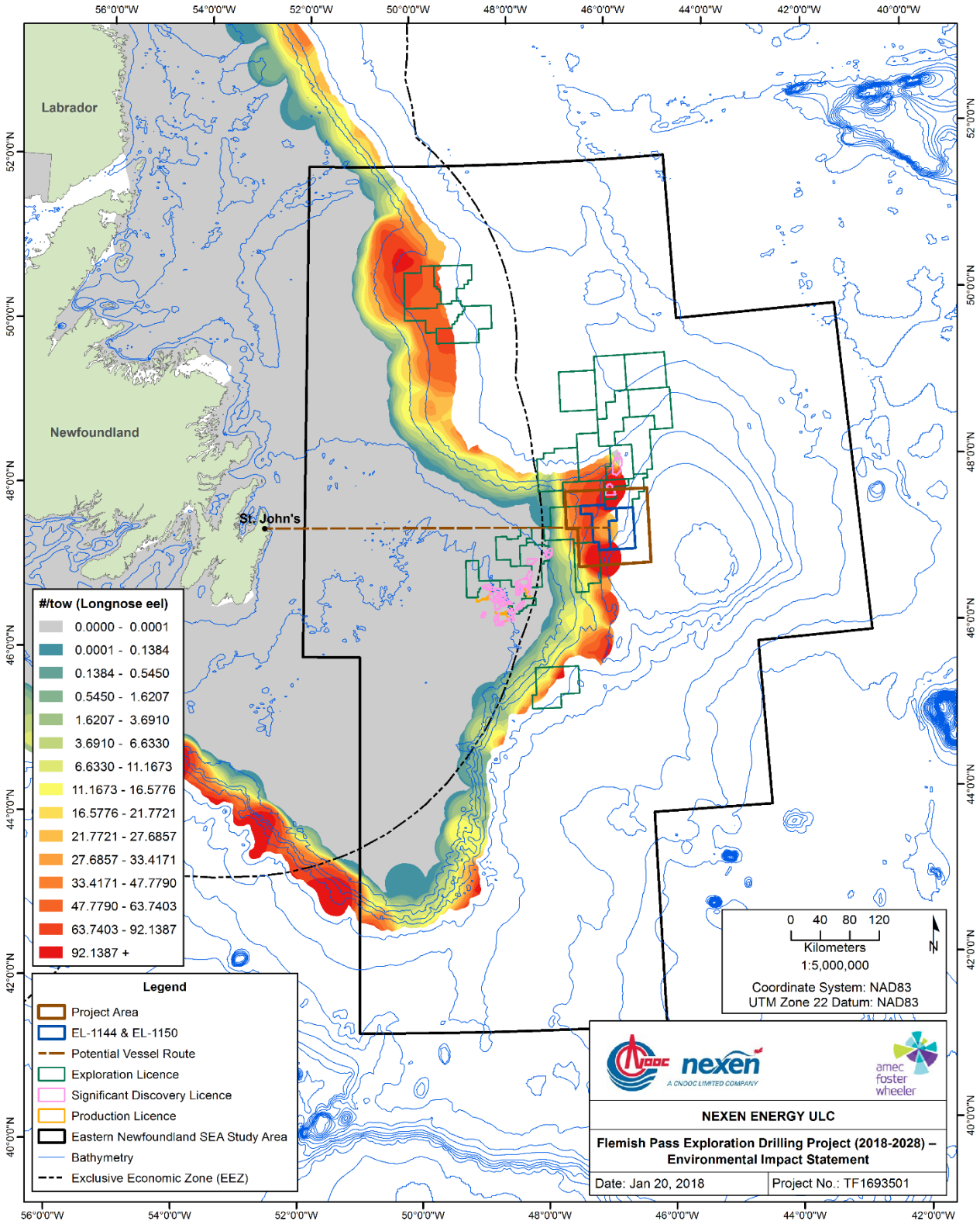


Figure 6.18 Distribution of Roughhead Grenadier Based on Canadian RV Surveys (2008-2012)

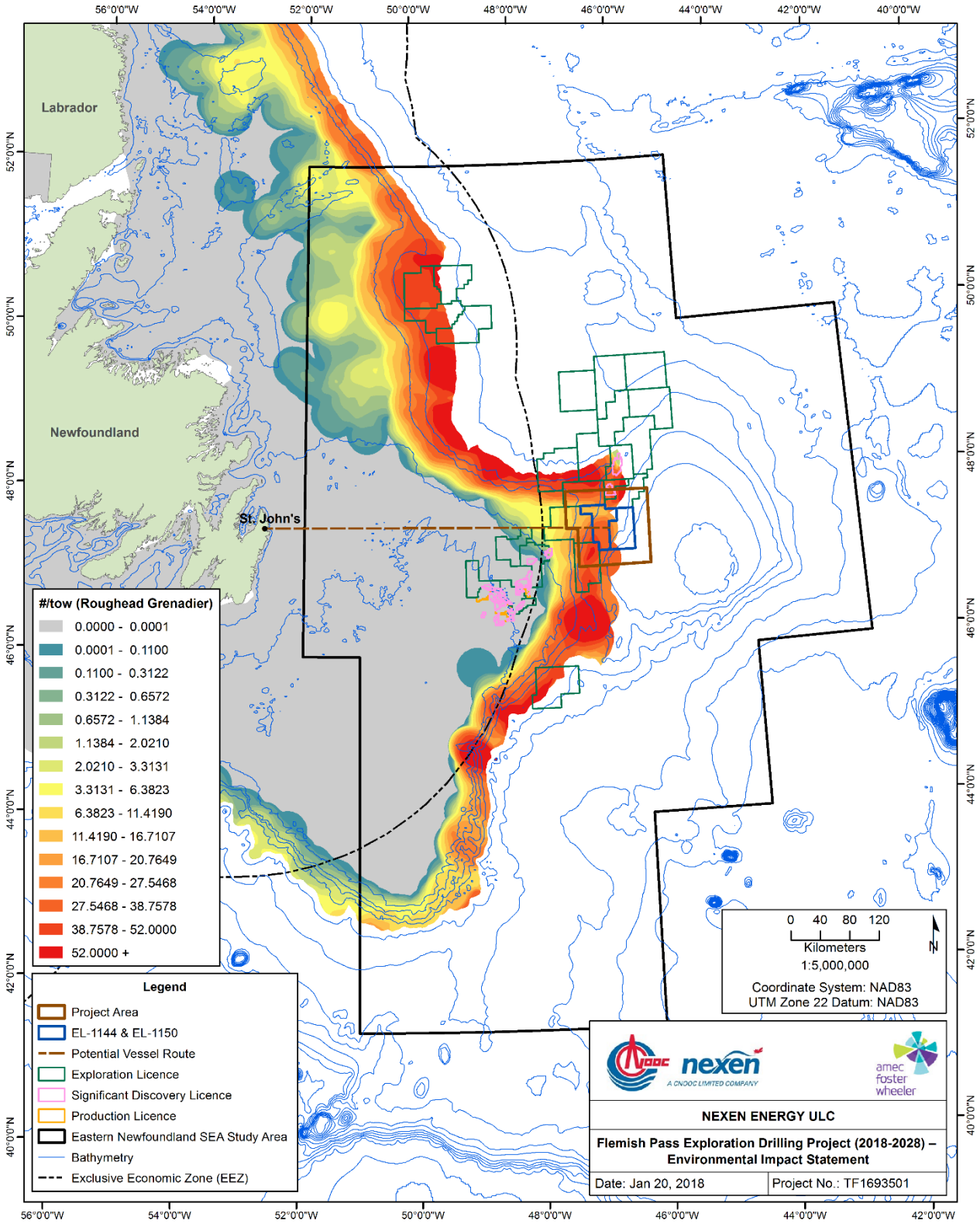


Figure 6.19 Distribution of Roughhead Grenadier Based on the Flemish Cap EU RV Surveys (2012-2015)

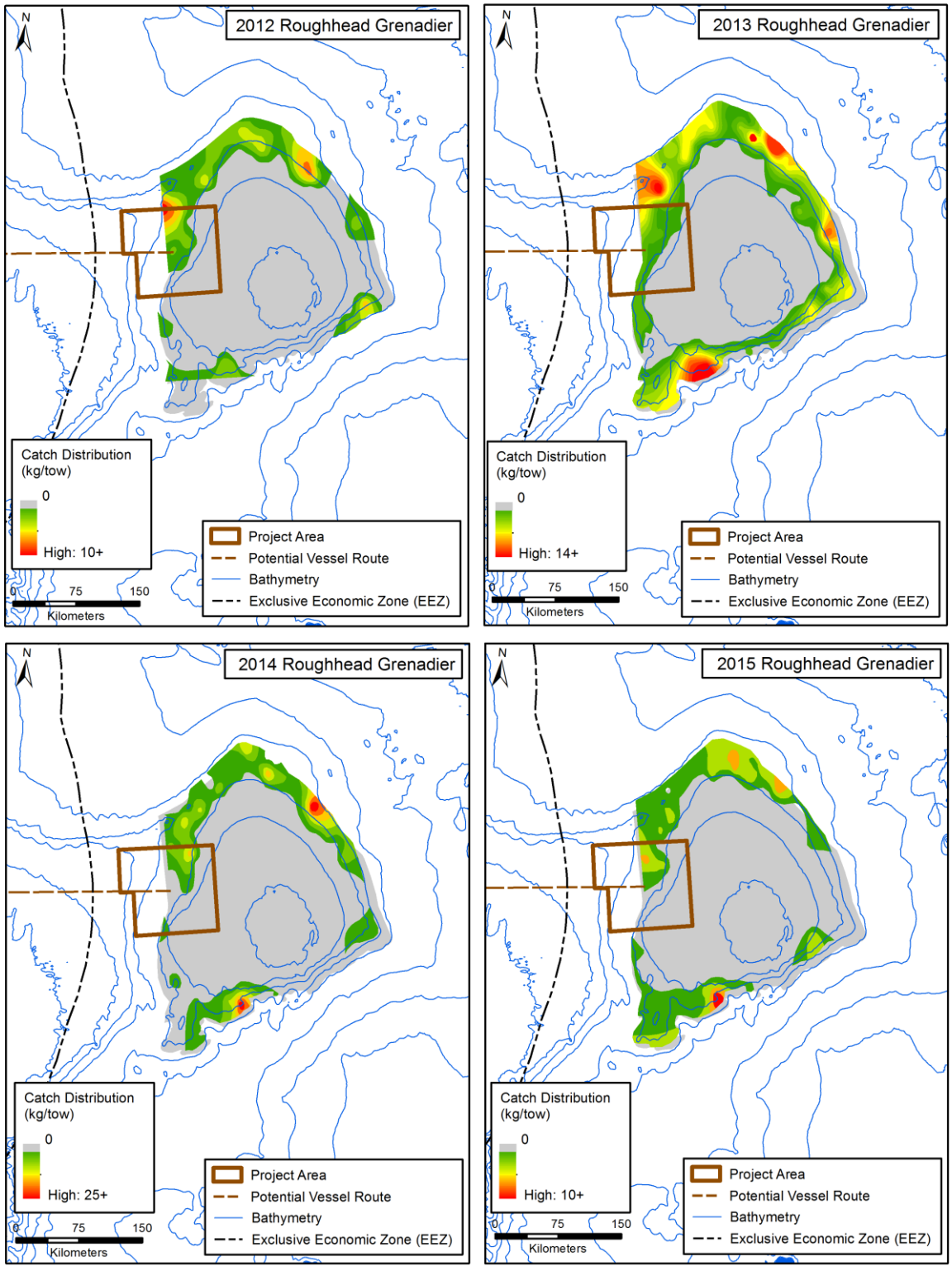


Figure 6.20 Distribution of Roundnose Grenadier Based on Canadian RV Surveys (2008-2012)

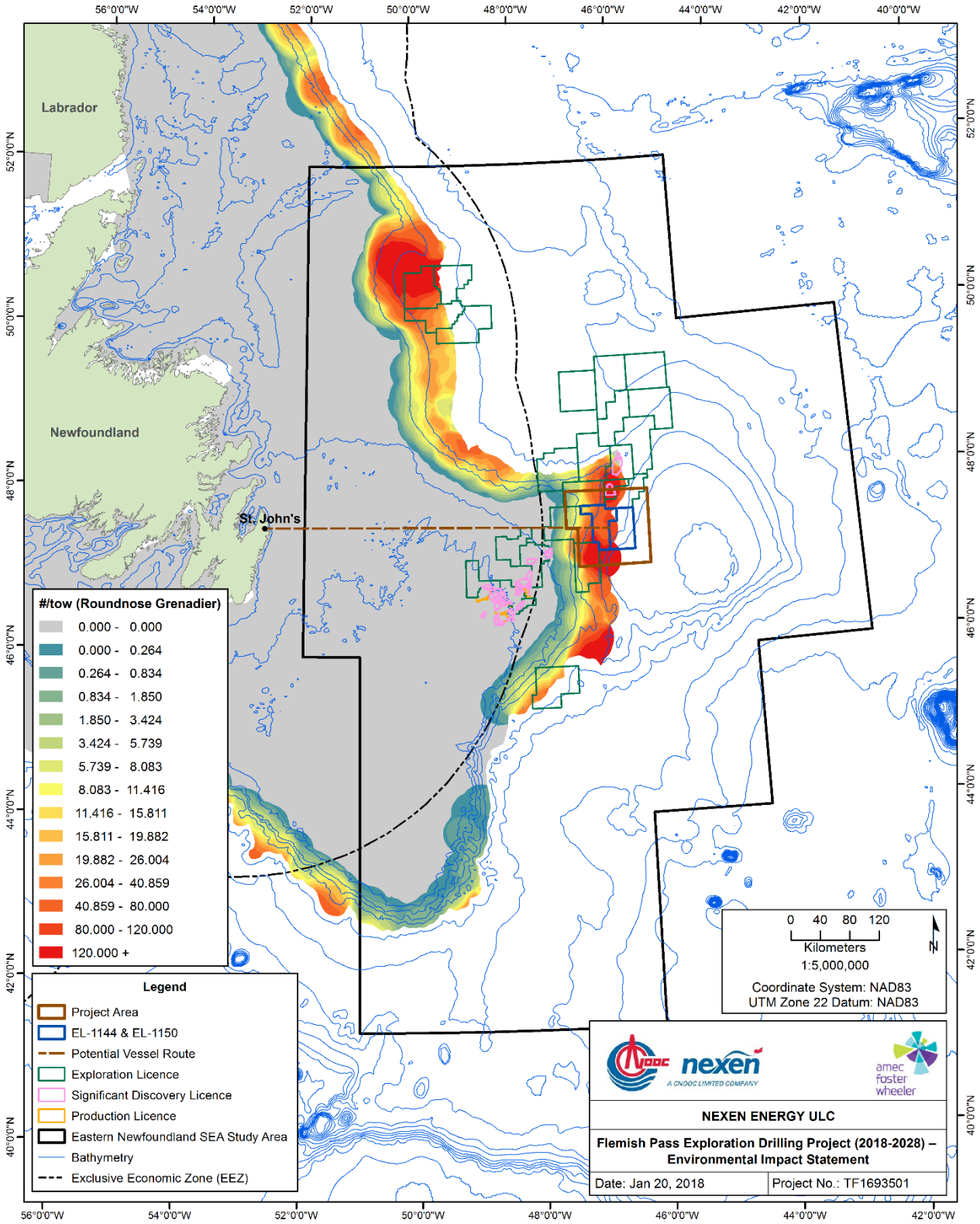


Figure 6.21 Distribution of Common Grenadier Based on Canadian RV Surveys (2008-2012)

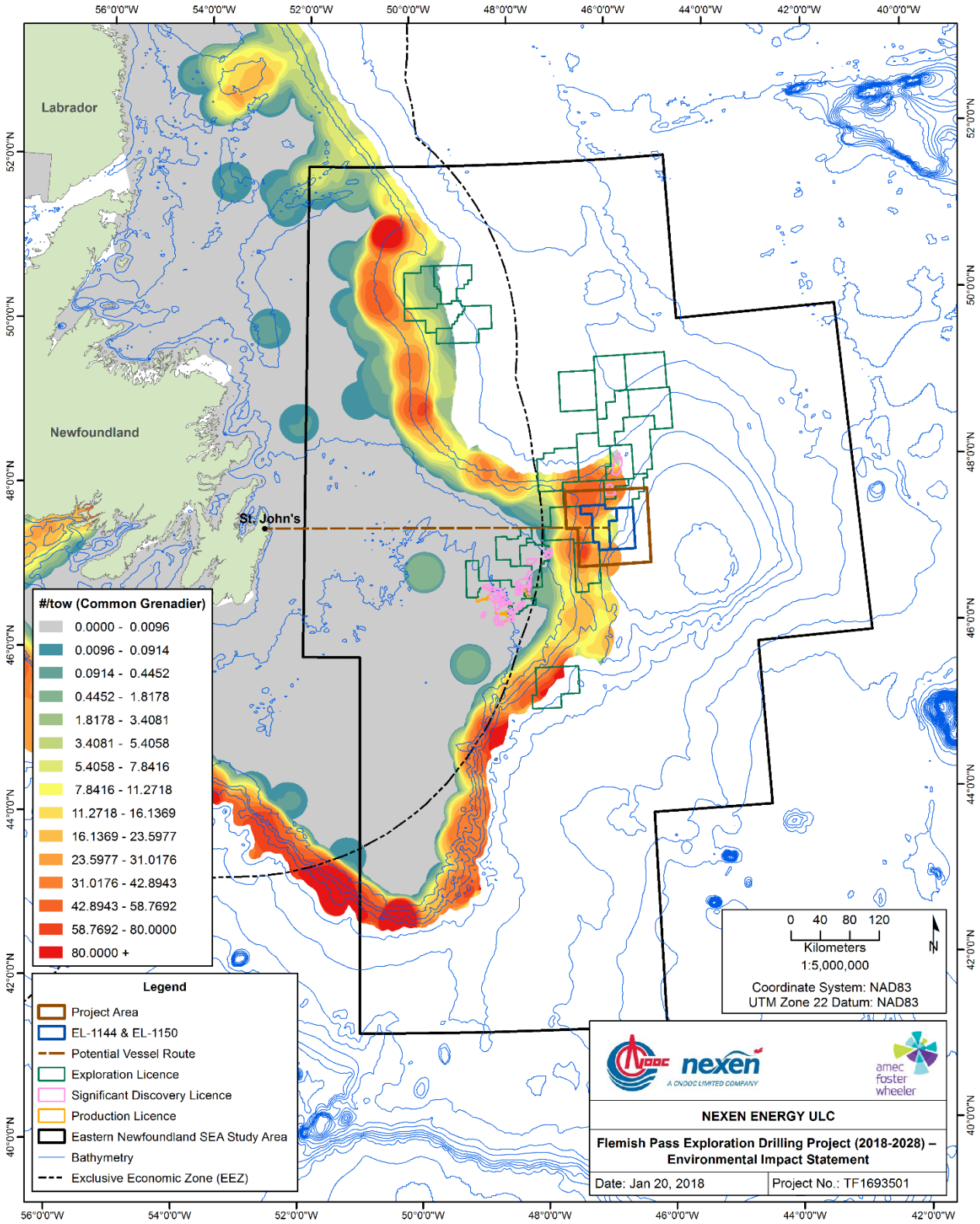


Figure 6.22 Distribution of Blue Hake Based on Canadian RV Surveys (2008-2012)

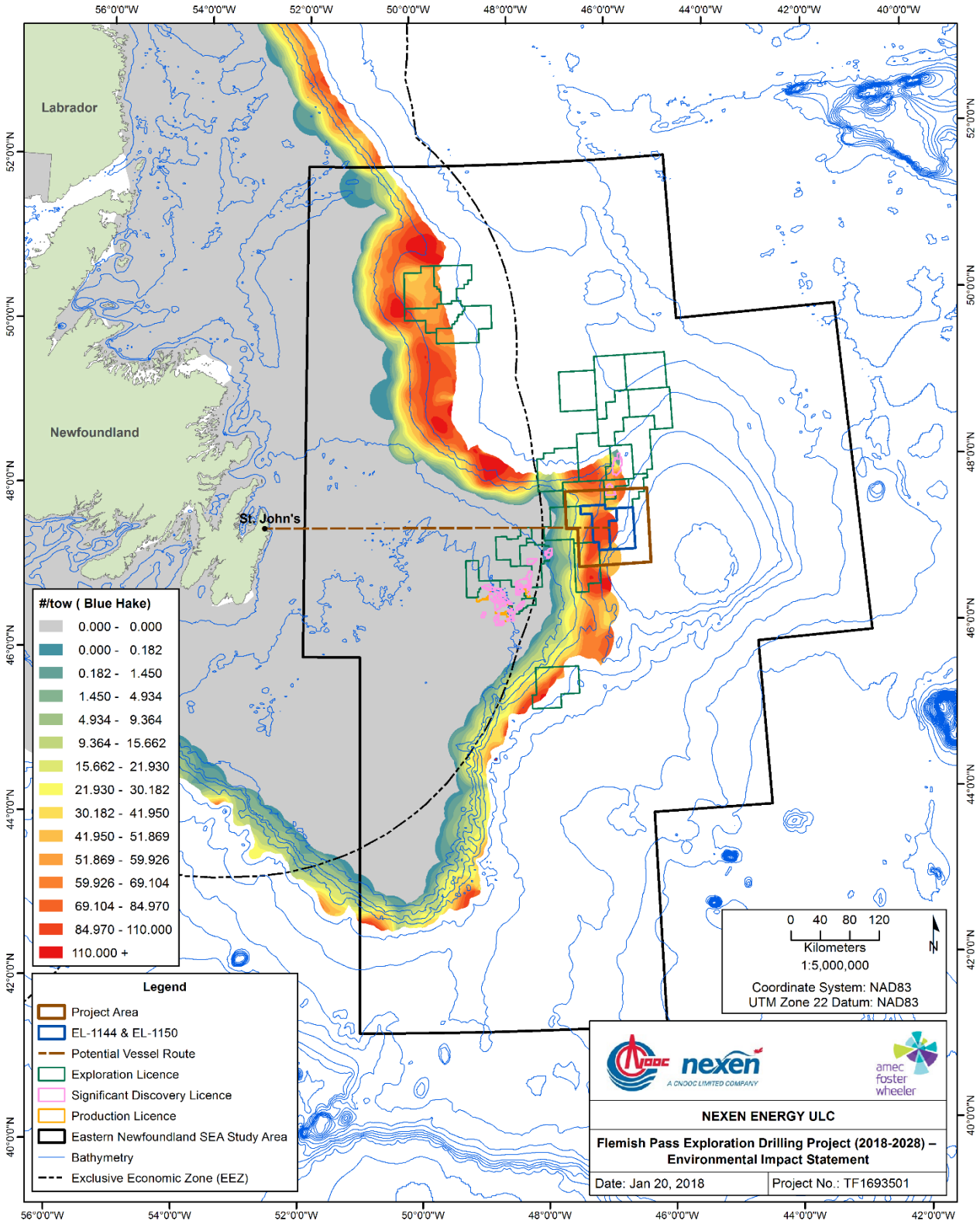


Figure 6.23 Distribution of Greenland Halibut Based on Canadian RV Surveys (2008-2012)

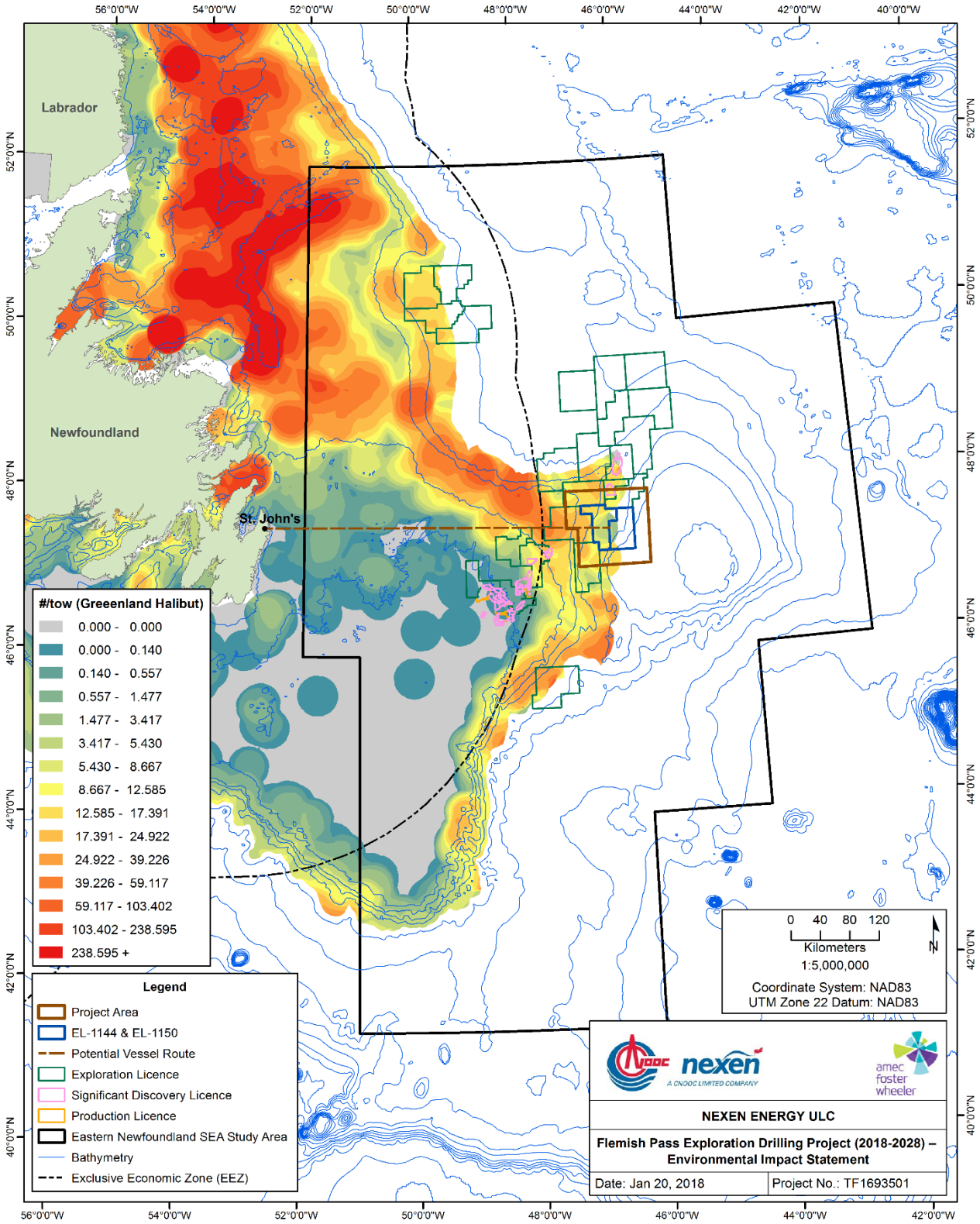


Figure 6.24 Distribution of Greenland Halibut Based on the Flemish Cap EU RV Surveys, (2012-2015)

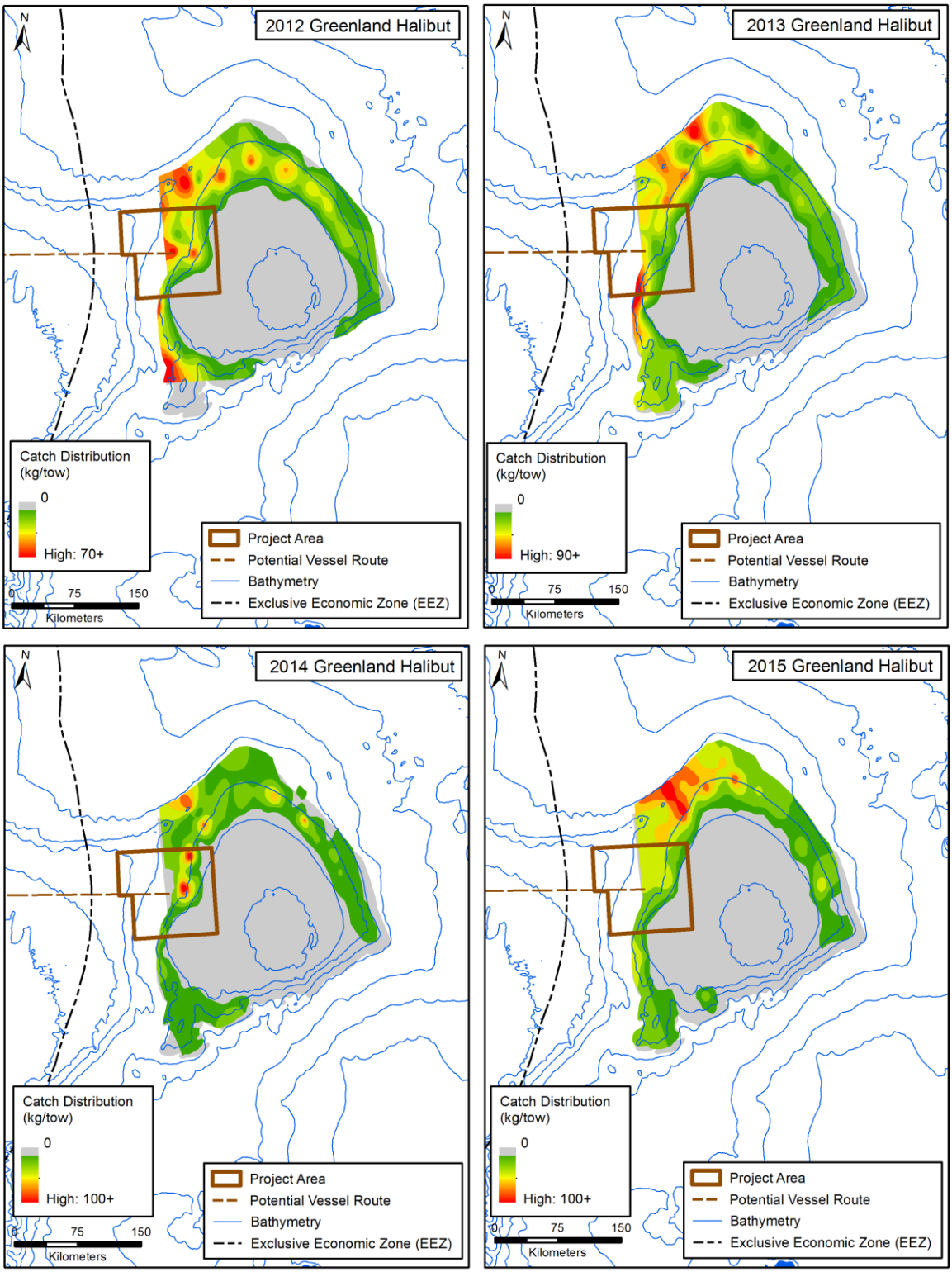


Figure 6.25 Distribution of Barracudina Based on Canadian RV Surveys (2008-2012)

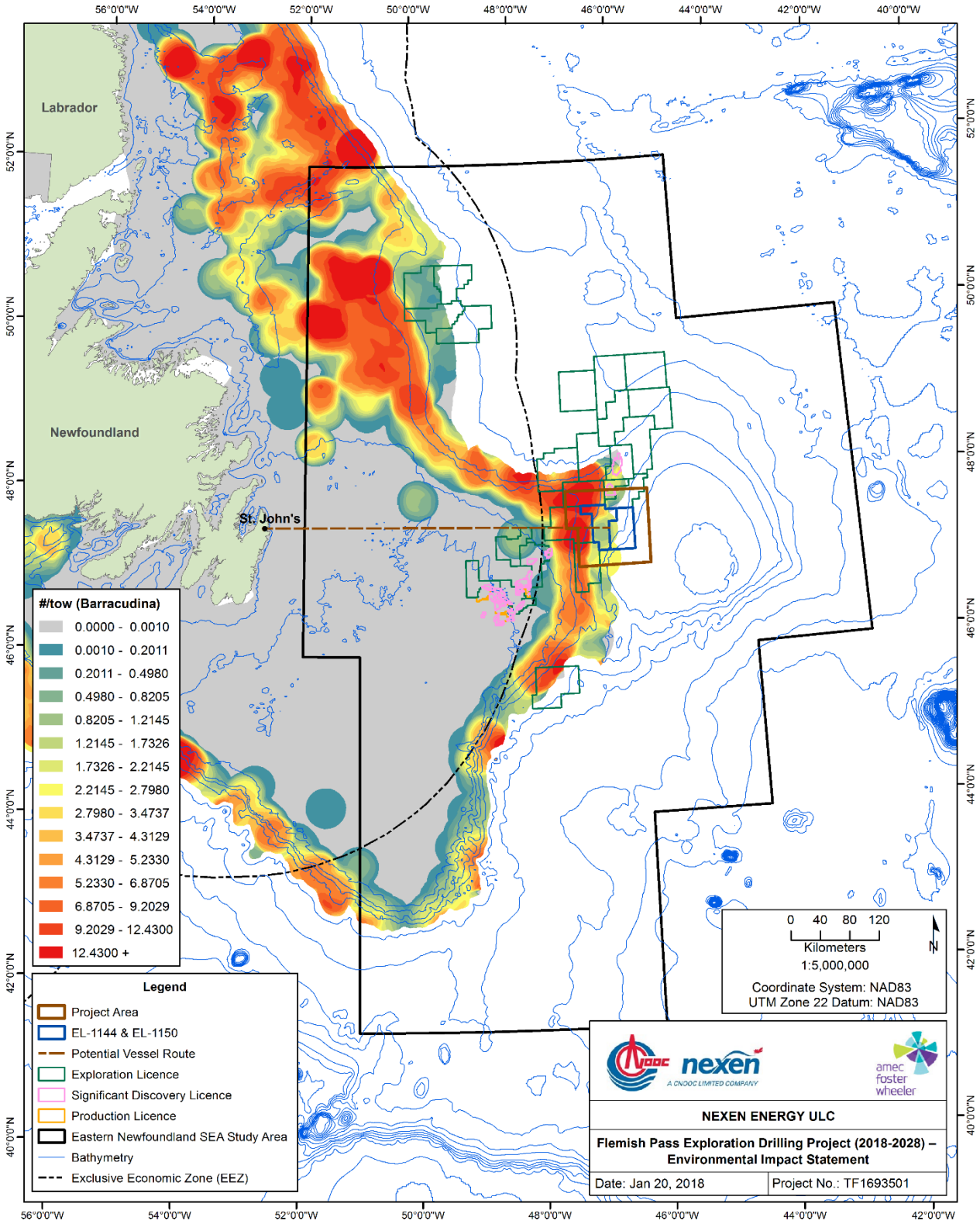


Figure 6.26 Distribution of White Hake Based on Canadian RV Surveys (2008-2012)

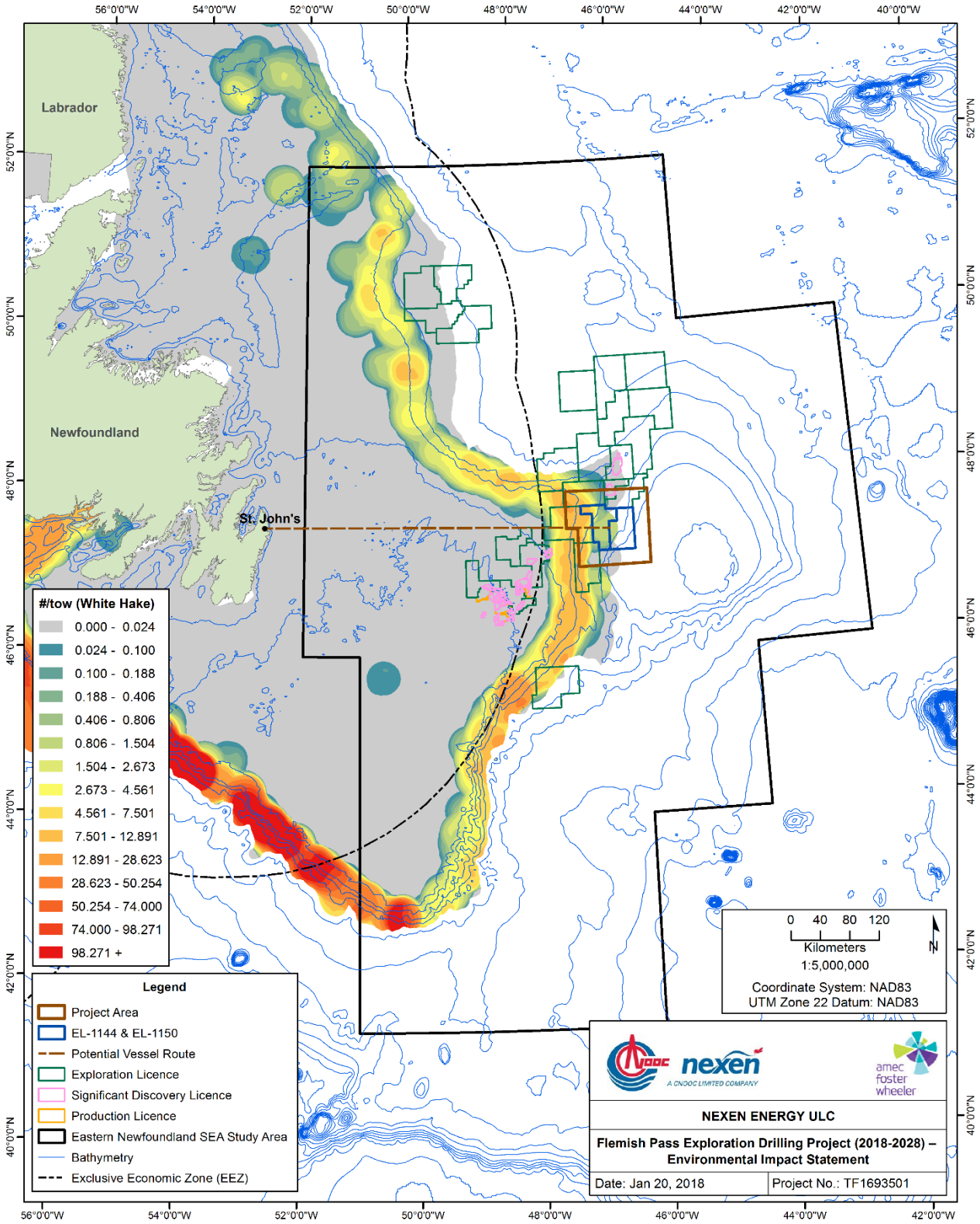


Figure 6.27 Distribution of Atlantic Cod Based on Canadian RV Surveys (2008-2012)

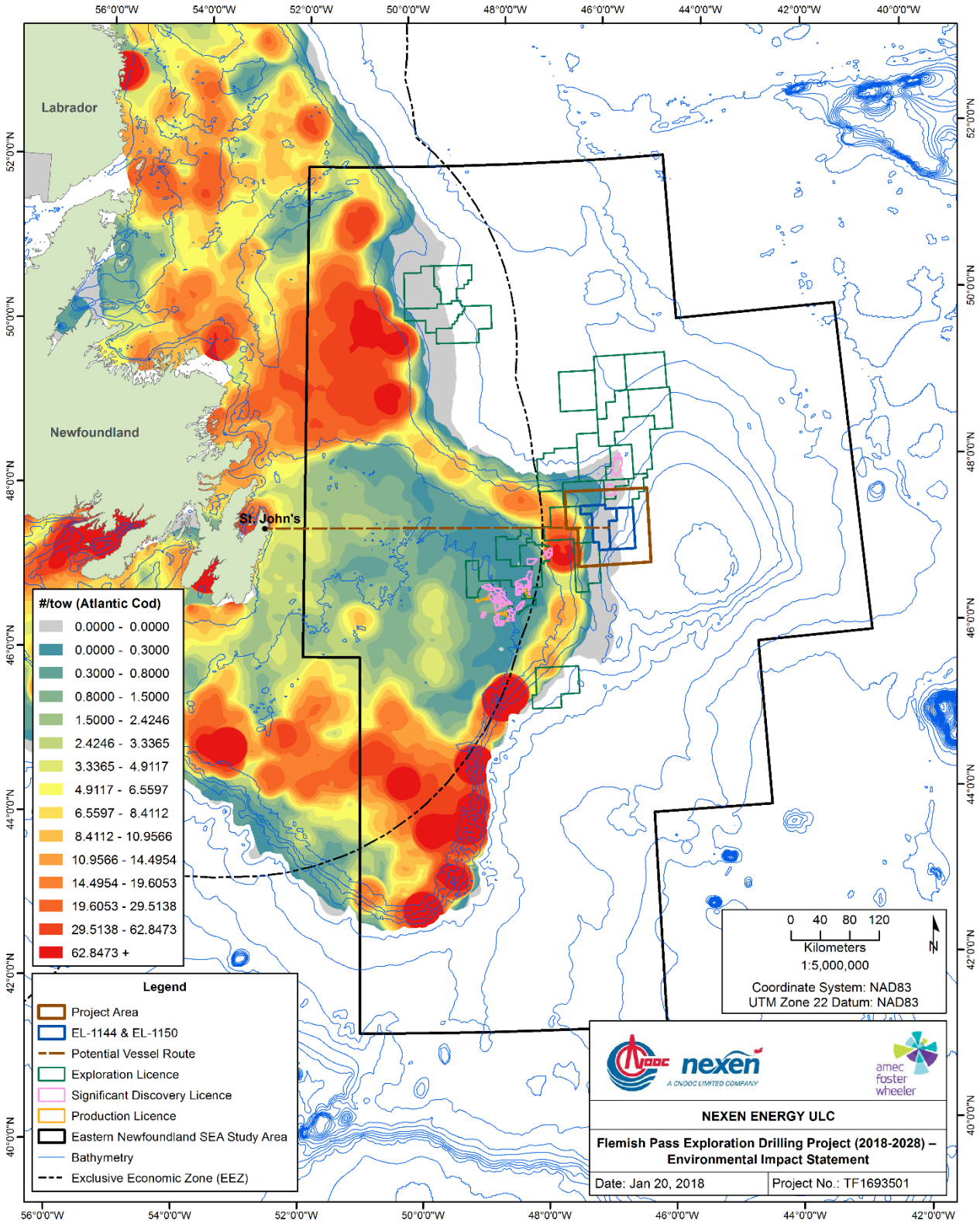
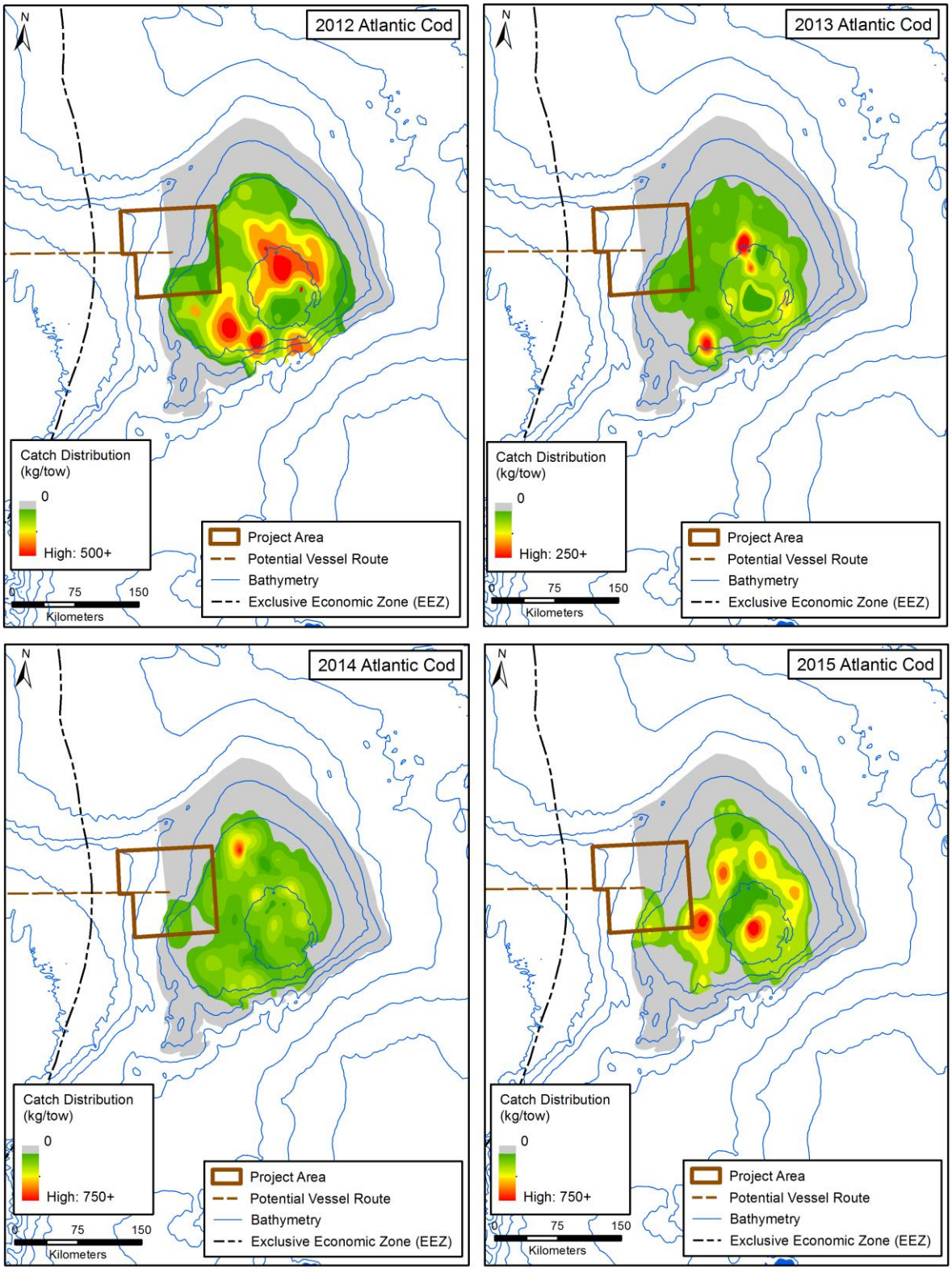


Figure 6.28 Distribution of Atlantic Cod Based on Flemish Cap EU RV Surveys (2012-2015)



6.1.7.4 Spawning

The various fish species that are found in the Project Area and larger RSA exhibit diverse reproductive strategies that include demersal spawning (such as skates, capelin) and broadcast spawning (Atlantic cod, white hake) as well as more specialized strategies such as diadromy (Atlantic salmon, American eels) and ovivipary (species such as sharks and redfish that give birth to live young). In many cases, spawning migrations take fish species well beyond Newfoundland's offshore to freshwater rivers, more shallow waters or tropical locations, whereas others are able to fulfill their whole life cycle in the area. Of those that remain, most are spring and early summer spawners. However, a few spawn in winter, such as Greenland halibut and roughhead grenadier. Spawning periods and known locations for select species are presented in Figure 6.29.

Figure 6.29 Spawning Periods and Locations for Key Species

Species	Spawning Time[1] J F M A M J J A S O N D	Key Spawning Locations
Lanternfish		No key areas established
Acadian Redfish[2]		Southwest Shelf Edge and Slope of Grand Bank
Deepwater Redfish[2]		Southwest Shelf Edge and Slope of Grand Bank
Golden Redfish[2,3]		Southwest Shelf Edge and Slope of Grand Bank
Longnose Eel		No key areas established
Common Grenadier		No key areas established
Roughhead Grenadier		Southern and southeastern slopes of the Grand Bank
Roundhead Grenadier[4]		No key areas established
Blue Hake[5]		No key areas established
Greenland Halibut		Davis Strait
Barracudina		Southwest tip of Ireland
White Hake[6]		Southwest Grand Banks Slope
Atlantic Cod[7,8]		Southeast shoal of Grand Bank, Burgeo Banks, Virgin Rocks[7, 8]

Sources: [1] Scott and Scott (1988); [2] COSEWIC (2010b); [3] Saborido-Rey et al (2015); [4]COSEWIC (2008); [5]White et al (2011); [6]COSEWIC (2013); and [7]COSEWIC (2010a) and [8] Templeman (2007).

6.1.7.5 Migration Patterns

Fish migration in temperate latitudes is common, allowing individuals to seek out seasonally abundant resources, avoid harsh environmental conditions and/or aggregate for activities such as spawning (Dingle and Drake 2007). Key migration strategies used by fish found in the Project Area and RSA are described in the Eastern Newfoundland SEA (Amec 2014) and include:

- Migrations from offshore wintering habitats to shallow coastal areas in summer (cod and capelin);
- Summer feeding migrations from southerly latitudes into the RSA by large warm water pelagic species such as tunas, swordfish and a variety of sharks;
- Migrations of freshwater spawners like Atlantic salmon, which may transit through the RSA between offshore feeding migrations and their natal rivers;
- Catadromous migrations of American eel, that may pass through offshore environments as they migrate between freshwater rearing environments and the Sargasso Sea spawning areas; and
- Movements within offshore habitats that can be exhibited by deep water species (such as redfish, wolffish and Greenland halibut) and some stock components of other species (including inshore populations of Atlantic cod).

An important consideration of migratory species is that their movements may extend well beyond the Project Area and RSA. For example, Atlantic salmon populations that have to migrate through the area could originate from rivers on the south coast of Newfoundland, the Maritimes or even the northeast United States (COSEWIC 2010c). Large pelagics (such as sharks) could have migration pathways that carry them across large portions of the Atlantic Ocean (Ocearch 2017).

Some migrations may also be conducted through the RSA, such as inshore-offshore migrations, whereas in other cases some generalized migration corridors can be identified. These include:

- Warm, deep water channels that are used to access inshore areas (such as the Bonavista Corridor); and
- The Southern Grand Bank, which likely experiences traffic from pelagics migrating to and from southerly latitudes.

6.1.8 Species at Risk and Otherwise of Special Conservation Concern

Species of conservation concern are identified by “arm’s length” conservation organizations such as COSEWIC and the International Union for the Conservation of Nature (IUCN). Some of these species are provided with legislative protection within Canadian (federal *Species at Risk Act* - SARA) and provincial (Newfoundland and Labrador *Endangered Species Act* - NL ESA) jurisdictions.

Within the Project Area and larger RSA, some 30 species have been identified as species of conservation concern with some species having overlapping designations under COSEWIC and IUCN.

There are 23 species that have been identified by COSEWIC and 23 species have been identified on the IUCN Redlist for the region and may occur in the area (Table 6.17). Several COSEWIC and IUCN assessed species may never have occurred in great densities in the RSA as it is peripheral to their typical range. Other listed species remain common, including American plaice, Atlantic cod, and redfish, but have experienced population declines, particularly during the groundfish collapse of the early 1990s.

There are currently four *SARA* (Schedule 1) listed and one *NL ESA* listed species that may occur within the Project Area and RSA, including three species of wolffish, the white shark, and the American eel (Table 6.17). Of the 30 listed species in the North Atlantic, 13 species have a higher potential to have ranges that overlap with the Project Area and/or the RSA and include Atlantic cod, white hake, thorny skate, grenadier species, redfish species, Atlantic salmon, shark species and Atlantic bluefin tuna. These species are further described below in terms of their biology, ecology and distribution with some numerically dominant fish species of the area previously described in Section 6.1.7. Further biological information is described in the Eastern Newfoundland SEA (Amec 2014).

Detailed information on Atlantic salmon migration and habitat patterns in the North Atlantic is also provided as baseline information to support the eventual analysis of potential effects on this migratory species, and its use for traditional activities by Indigenous peoples (Section 7.4 and Chapter 12).

Table 6.17 Fish Species at Risk or Otherwise of Special Conservation Concern

Family	Species		Status / Designation[1]			
	Common Name	Scientific Name	*NL ESA*	*SARA* Status (Schedule 1)	COSEWIC Designation	IUCN
Anarhichadidae	Striped (Atlantic) wolffish	*Anarhichas lupus*		SC	SC	
Anarhichadidae	Northern (Broadhead) wolffish	*Anarhichas denticulatus*		T	T	
Anarhichadidae	Spotted wolffish	*Anarhichas minor*		T	T	
Anguillidae	American eel	*Anguilla rostrata*	V		T	E
Carcharhinidae	Blue shark	*Prionace glauca*			NR	NT
Cetorhinidae	Basking shark	*Cetorhinus maximus*			SC	V
Gadidae	Atlantic cod (Newfoundland and Labrador Population)	*Gadus morhua*			E	V
Gadidae	Cusk	*Brosme brosme*			E	
Gadidae	Haddock	*Melanogrammus aeglefinus*				V
Lamnidae	Porbeagle	*Lamna nasus*			E	V
Lamnidae	Shortfin mako	*Isurus oxyrinchus*			T	V
Lamnidae	White shark	*Carcharodon carcharias*		E	E	V
Macrouridae	Roughhead grenadier	*Macrourus berglax*			SC	
Macrouridae	Roundnose grenadier	*Coryphaenoides rupestris*			E	CE

Family	Species		Status / Designation[1]			
	Common Name	Scientific Name	*NL ESA*	*SARA* Status (Schedule 1)	COSEWIC Designation	IUCN
Phycidae	White hake (Atlantic and Northern Gulf of St. Lawrence Population)	*Urophycis tenuis*			T	
Pleuronectidae	American plaice (Newfoundland and Labrador Population)	*Hippoglossoides platessoides*			T	
Pleuronectidae	Atlantic halibut	*Hippoglossus hippoglossus*				E
Rajidae	Barndoor skate	*Dipturus laevis*				E
Rajidae	Little skate	*Leucoraja erinacea*				NT
Rajidae	Smooth skate (Funk Island Deep Population)	*Malacoraja senta*			E	E
Rajidae	Spinytail skate	*Bathyraja spinicauda*				NT
Rajidae	Thorny skate	*Amblyraja radiata*			SC	V
Rajidae	Winter skate (Eastern Scotian Shelf – Newfoundland)	*Leucoraja ocellata*			E	E
Salmonidae	Atlantic salmon (South Newfoundland Population (T); Quebec Eastern North Shore (SC), Quebec Western North Shore (SC), Anicosti Island (E), Inner St. Lawrence (SC), Gaspe-Southern Gulf of St. Lawrence (SC), Eastern Cape Breton (E), Nova Scotia Southern Upland (E); Outer Bay of Fundy Population (E))	*Salmo salar*			T; E; SC	LC
Scombridae	Albacore tuna	*Thunnus alalunga*				NT
Scombridae	Atlantic Bluefin tuna	*Thunnus thynnus*			E	E
Scombridae	Bigeye tuna	*Thunnus obesus*				V
Scorpaenidae	Acadian redfish (Atlantic Population)	*Sebastes fasciatus*			T	E
Scorpaenidae	Deepwater redfish (Northern Population)	*Sebastes mentella*			T	LC
Squalidae	Spiny Dogfish	*Squalus acanthias*			SC	V

[1] Not at Risk (NR), Least Concern (LC), Vulnerable (V), Near Threatened (NT), Special Concern (SC), Threatened (T), Endangered (E), Critically Endangered (CE)

6.1.8.1 Wolffish

Striped (Atlantic), northern (broadhead) and spotted wolffish have either “special concern” or “threatened” designations under *SARA*. All three species are slow growing and long lived, characteristics that limit their recovery potential from stressors including by-catch mortality or habitat

alteration. Populations of all three species have declined in Canadian waters since the 1980s due mainly to commercial fishing by-catch mortality, however there has been a small upward trend since the mid 1990s (COSEWIC 2012a, 2012b, 2012c). Proposed measures to increase population levels and distributions as part of the Recovery Strategy and Management Plans include increasing research on each species, protecting habitat, monitoring and mitigating human impacts (Kulka et al 2007). Migrations of northern and spotted wolffish are limited based on tagging studies, however striped wolffish may undergo longer migrations as they move to inshore waters to spawn (Kulka et al 2007). At this time, no critical habitat has been established for these species as there is limited information on life history, influences on population dynamics and information on acceptable targets for population abundance and range (Kulka et al 2007). No potential critical habitat has been established for striped wolffish as it is not a requirement of "special concern" *SARA* designation.

Striped and spotted wolfish lay egg clusters on the bottom that are guarded by adults. Following hatching, the wolffish larvae become pelagic and are commonly found over continental slopes. The life history of northern wolffish is somewhat less known, but it may be similar in nature to the other two related species (Kulka et al 2004).

Striped and spotted wolffish primarily feed on invertebrates (68-85 percent) including echinoderms, crustaceans, and bivalves. Fish are consumed to a lesser extent (15-23 percent of diet) by these species (COSEWIC 2012b,c). Northern wolffish that are associated with pelagic environments primarily feed on pelagic fish and invertebrates including jellyfish and gelatinous zooplankton (COSEWIC 2012d). Larval wolffish are thought to consume zooplankton including crustaceans, fish eggs and fish larvae (COSEWIC 2012d).

Habitat requirements and preferences differ considerably across these three species. Striped wolffish generally frequent depths of less than 100 m with peak abundance around 250 m depths and below the thermocline (COSEWIC 2012a). Juveniles and adults of this species generally inhabit areas of rocky and sandy bottoms and require caves or boulders for spawning (COSEWIC 2012a). Spotted wolffish mainly frequent intermediate water depths (200-750 m) with no apparent substrate type preferences (COSEWIC 2012b). Northern wolffish have a wide depth range (38-1,504 m), but tend to occupy pelagic areas more than the other two wolffish species and are associated with sand and shell substrates (COSEWIC 2012c).

The Canadian RV Survey data support the scientific literature conclusions for wolffish distributions, including that the northern wolffish was typically distributed in deeper waters (Figure 6.30). Areas of aggregation for the northern wolffish included the northeast slope of the Grand Banks and slopes of the Newfoundland and Labrador shelf in areas of 250-600 m depth. Northern wolffish had the highest abundance of the three species based on Canadian RV surveys. Areas of high abundance for all three species were associated with deep slope areas and the Flemish Pass. However, the striped wolffish (Figure 6.31) was more widespread, occurring in many areas of the continental shelf at lower abundance. Striped wolffish were mainly distributed between 600-1,000 m based on Canadian RV data, however on the Flemish Cap they are associated with shelf areas (less than 250 m). Spotted wolffish were mainly associated with areas greater than 600 m depth on both the Grand Banks and Flemish Cap slopes (Nogueria et al 2017; Figure 6.32).

6.1.8.2 American Eel

American eels are a catadromous species that spawns in the marine environments and migrate to freshwater environments for rearing and growth. This species is listed as “vulnerable” under the *NL ESA* and “threatened” by COSEWIC. There has been a general decline in American eel abundance for over the past two or more generations in Canada (Cairns et al 2014). While there have been some increases to stocks in the Gulf of St. Lawrence, declines have been observed for Lake Ontario, Newfoundland and Nova Scotia and Bay of Fundy areas (Cairns et al 2014). Threats to eel populations include barriers to freshwater migration and habitat fragmentation, contaminants, parasites and shifting environmental conditions that may affect ocean migrations (COSEWIC 2012d). No critical habitat has been established for American eel (Wildlife Division 2010; COSEWIC 2012d), however it has been noted that freshwater riparian areas may be important habitat for developing eels (Wildlife Division 2010; COSEWIC 2012d). The Sargasso Sea, that lies approximately 2,000 km south of Canadian waters, is an area of importance for spawning and reproduction (COSEWIC 2012d), but it is quite distant from the Project Area.

American eel larvae feed on particulate matter and detritus, switching to primarily insect larvae as they occupy estuarine coastal habitats (COSEWIC 2012d). Adult eels in freshwater consume fishes, molluscs, crustaceans, insects, worms, and plants, however feeding activity declines during winters and ceases as eels prepare physiologically for their spawning migration to the Sargasso Sea (COSEWIC 2012f).

Adult American eels migrate from freshwater environments to the Sargasso Sea off Bermuda to spawn from approximately February to April, with adults dying shortly after reproduction (Figure 6.33) (Cairns et al 2014; Rypina et al 2014). Adult eel migrations follow the shallow shelf areas before travelling directly to the Sargasso Sea in deeper waters. The resulting eggs transform into leptocephali larvae and migrate to coastal areas of North America through passive drifting and directional swimming (Rypina et al 2014). During this dispersal, the pelagic larvae are concentrated in the water column in the upper 140 m at night and the upper 350 m during the day (McCleave and Kleckner 1982). The larvae metamorphose into the glass eel stage before reaching estuarine and freshwater coastal nursery habitats where they develop into juveniles that eventually migrate into freshwater lakes and rivers (Rypina et al 2014). American eels are part of a large panmictic population with little genetic differentiation between eels from various locations (Côté et al 2014).

6.1.8.3 White Shark

The white shark is listed as “endangered” under *SARA*. White shark are not regularly captured in Canadian waters and their abundance is considered less than southern regions (COSEWIC 2006). A directed fishery for this species is not conducted in Canadian waters, however by-catch mortality remains a threat to this species. To date, no critical habitat has been established for white shark (COSEWIC 2006a).

White sharks inhabit inshore and offshore waters and the intertidal zone to continental slopes (COSEWIC 2006a) and is distributed in sub-polar to tropical seas. White sharks have been observed from Newfoundland and the Grand Banks to the Gulf of Mexico, but they are primarily distributed off the eastern coast of the US (COSEWIC 2006a; Curtis et al 2014). Their distribution ranges are seasonal, with sharks frequenting areas off the southeastern US in winter months and expansion to northern parts

of their range in the spring to summer (Curtis et al 2014). Ocearch (2017) has also tracked female white sharks from the continental shelf and slopes south of Newfoundland to the Flemish Cap (Figure 6.34), however the majority of white sharks occupy waters off the east coast of the United States. White sharks diets are comprised of fish, other sharks, marine mammals, and squid (COSEWIC 2006a).

6.1.8.4 Other Sharks

Under COSEWIC, Basking shark are listed as special concern, shortfin mako sharks are listed as threatened and porbeagle are listed as endangered. To date, no critical habitat has been established for these species (COSEWIC 2006b; 2009).

Basking and shortfin mako sharks occur in Canadian waters in summer months, indicating they may be associated with the seasonal shift of warm Gulf Stream toward the coast. Basking sharks occur throughout Atlantic continental shelf including the Bay of Fundy, Scotian Shelf and Grand Banks. Distribution data from the Newfoundland Observer Program from 1980-2004 indicate that the sharks are found on the Flemish Cap and the Northeast slope of the Newfoundland Shelf (COSEWIC 2009). Shortfin makos are typically associated with the warm waters in and around the Gulf Stream and have been captured from the continental shelf of Nova Scotia, the Grand Banks and the Gulf of St. Lawrence (COSEWIC 2006b). Shortfin mako presence is seasonal and are found in Canadian waters from the later summer to fall. It is suggested that individuals observed in Canadian waters represent only a small proportion of the population (COSEWIC 2006b). Migration routes for shortfin mako are mainly in offshore areas outside the continental shelf including the Newfoundland Shelf and Flemish Cap (Vaudo 2017). Basking sharks feeds on zooplankton whereas shortfin mako sharks primarily consume pelagic fishes including tunas, mackerel, swordfish and squid (COSEWIC 2006b; 2009b).

For porbeagle sharks In Canadian waters, early, juvenile and adult life stages are abundant on or near the continental shelf (COSEWIC 2014). Their distribution includes the Project Area on the continental shelf (COSEWIC 2014). They are rarely captured at the surface or at depths greater than 200 m in Canadian waters. No critical habitat has been established for this species, however there are mating grounds that lie outside the Project Area on the Grand Banks off southern Newfoundland, the entrance to the Gulf of St Lawrence, and the Georges Bank. Porbeagle sharks mate in this area in the summer and early fall and migrate south in the winter to the pupping grounds in the Sargasso Sea (COSEWIC 2014). Historical fisheries that overexploited the species and current by-catch mortality, combined with slow recovery all affect porbeagle populations. Porbeagles feeds opportunistically on pelagic, epipelagic and benthic species, though primarily on fishes and squid (COSEWIC 2014).

6.1.8.5 Thorny Skate

Thorny skate are listed as “special concern” by COSEWIC. Thorny skates are one of the most abundant skate species in Canadian RV surveys and are densely concentrated and abundant on the Grand Banks (Figure 6.35) (COSEWIC 2012e). By-catch mortality in commercial fisheries is the main threat to this species and no critical habitat has been established.

This slow growing species occupies depths of 18-1,400 m and inhabit a broad range of substrates including sand, shell, gravel and mud (COSEWIC 2012e). Skates lay egg capsules on the seafloor year-round and all life stages occupy demersal habitats, and undergo limited seasonal migrations of approximately 100 km, with some skates migrating up to 440 km (COSEWIC 2012e). Areas of high

aggregation include the Newfoundland Shelf and slopes and the southern Grand Banks. Thorny skate feed primarily on decapod crustaceans, euphasuiids, polychaetes, squid, and fishes including capelin and sand lance.

6.1.8.6 Atlantic Salmon

Atlantic salmon occupy freshwater, estuarine and marine environments and populations in Atlantic Canada are listed from “special concern” to “endangered”. The main threats and limiting factors to Atlantic salmon include predation, climate change, fisheries, by-catch mortality, obstructions to spawning areas, and aquaculture. There have also been large declines in marine survival, but the mechanism for mortality is poorly understood. It is suggested that declines in sea survival are occurring in parallel with wide spread changes in the North Atlantic ecosystem (COSEWIC 2010c). To date, there has not been any marine-based critical habitat established for this species, however freshwater habitat is considered a limitation to salmon production (COSEWIC 2010c).

Atlantic salmon occur in approximately 2,500 rivers flowing into the North Atlantic Ocean and despite extensive research on the freshwater portion of their life history, less is known about their life history once they leave their natal rivers and undertake migrations in the North Atlantic Ocean (COSEWIC 2010c; Lefevre et al 2012, Windsor et al 2012). Anadromous Atlantic salmon typically leave their natal rivers during the spring as smolt and spend from one to four years in the marine environment before returning to spawn as adults (Gardner 1976; COSEWIC 2010c). During their first winter at sea, young salmon are called post-smolt; after their first winter, they are called adult salmon regardless of the number of subsequent winters at sea prior to returning to their home river.

Salmon post-smolt and adults feed on various plankton, crustaceans, and larval fish (Lacroix and Knox 2004; Sheehan et al 2012) in the upper water layers (Reddin and Friedland 1993). Both post-smolt and adult salmon tend to spend most of their time within the upper water layers, generally in the upper 5-10 m (Reddin and Shearer 1987; Reddin and Friedland 1993; Hedger et al 2017; Strøm et al 2017), although recent research with satellite ‘pop-up’ tags are indicating that adults may also use deeper water (i.e., European salmon have been recorded making dives up to 900 m) (Windsor et al 2012; Hedger et al 2017; Strøm et al 2017). Salmon tagged from Campbellton River in Newfoundland were frequently present at depths of more than five meters (Windsor et al 2012).

The distribution and movement patterns of both post-smolt and adult salmon within the marine environment are highly complex and much information comes from studies related to commercial fisheries, research trawls, and tagging studies (Reddin and Friedland 1993; Reddin 2006). The North Atlantic Salmon Conservation Organization (NASCO) has been reanalyzing historic tag recovery data and has begun additional research using methods such as genetic population assignments, baseline microsatellite genetic data, stable isotopes, “pop-up” satellite and acoustic tagging (Windsor et al 2012); however, many of these analyses are ongoing. The available results of past and ongoing research provide insight to patterns of migration, food resources, distribution and abundance but also associations to environmental factors (Reddin and Freidland 1993; Reddin 2006). While there has been limited sampling directly in the Flemish Pass area, research trawl data near the Grand Banks and throughout the known range of Atlantic salmon in the North Atlantic provide information on behaviours and preferred habitats of both post-smolt and adults which can be assimilated to infer marine habitat use and preferences. A summary of overall habitat use in the North Atlantic Ocean and a description of the suitability of habitat near the Project Area and beyond is provided below.

Commercial and research vessel catches indicate that Atlantic salmon of all sea-ages occur seasonally over most of the northwest Atlantic (Reddin and Shearer 1987, Reddin and Friedland 1993, Reddin 2006; Sheehan et al 2012). Atlantic salmon smolt are generally considered to be “energy-deficient” and have low energy reserves for somatic growth upon leaving their natal river and during the early marine phase (Jonsson and Jonsson 2003). It has been suggested that post-smolt are therefore distributed according to prevailing surface currents either close to shore or in open waters and that strong currents act as transportation vectors that facilitate migration to marine feeding areas (Jonsson et al 1993) to reduce energy needs. Therefore, the migration routes of post-smolt from any river may be determined by general ocean currents near its confluence with the ocean.

In general, there are concentrations of both post-smolt and adult salmon in the Labrador Sea throughout the year where they feed and overwinter (general location shown in Figure 6.36). Reddin and Friedland (1993) indicate that post-smolt were observed in the Labrador Sea in autumn of all study years and that they were most abundant between 56°N and 58°N (i.e., northern Labrador Sea area). Post-smolt in the Labrador Sea originate from rivers over much of the geographical range of salmon in North America and most post-smolt overwinter in the southern portion of the Labrador Sea (Reddin and Friedland 1993). Catch data in Reddin and Friedland (1993) indicate that post-smolt do not overwinter in the Grand Banks area during the period 23 December – 21 March. Reddin (2006) notes that post-smolt may overwinter off the Grand Banks but states that corroborative evidence from directed research or indirectly by commercial vessels fishing during the winter is lacking.

Adult salmon, primarily multi-sea-winter (MSW) fish, are also found off west Greenland during summer and fall. Prior to their spring spawning migration to their home rivers, adult salmon have been found congregating in two general offshore locations: Reddin and Friedland (1993) describe these at approximately 480 km east of the Strait of Belle Isle (western edge of Labrador Sea area, Figure 6.36) and slightly east of the 200 m depth contour along the eastern edge of the Grand Banks (East Grand Banks area Figure 6.36). Based on catch data provided in Reddin and Shearer (1987) (Figure 6.37), the area of congregation on the eastern edge of the Grand Banks would be located south of the Flemish Pass. Sampling near the Flemish Pass in winter and summer/autumn captured no salmon (Reddin and Shearer 1987). Low catches (over 0.0-1.0 salmon per mile-hour of drift gillnet) of adult salmon were recorded during the spring (Redden and Shearer 1987).

Scales from post-smolt salmon can indicate the general geographic location of their natal river; younger post-smolt (i.e., those smolt that leave their natal river at a younger age) are typically from more southern rivers (Lear and Misra 1978). For example, Labrador mainly produces smolt of river age four and older while Newfoundland smolt typically have river ages of three and four. Rivers to the south of Newfoundland in Nova Scotia, Bay of Fundy, and the United States typically produce smolt of river ages one and two (Reddin 2006). Age data, as well as river recaptures of salmon tagged off the Grand Banks (see Figure 6.38), indicate that salmon that congregate along the eastern Grand Banks are generally from more southern regions such as the Maritimes.

Research to date provides an overview of general habitat use but also a description of suitable, preferred environmental conditions for salmon survival and growth. Changes in environmental conditions can spatially alter typical distributions and migration routes (Reddin and Shearer 1987) as well as marine survival (Reddin 2006). For example, catch data suggest that salmon modify movements at sea depending on sea surface temperature (SST). Reddin and Shearer (1987) and Reddin and Friedland (1993) found a statistically significant and marked relationship between commercial catch

rates and the boundary limit of the 4°C isotherm. They showed that few salmon were located at lower temperatures and none below 3°C. The most appropriate temperature range for salmon, based on catch/abundances, has been determined to be 4-12°C SST in the Northwest Atlantic with an optimum between 4-8°C (Reddin and Friedland 1993). Reddin and Burfitt (1984) examined the relationships between salmon catch rate, SST and prey abundance and concluded that SST is the main predictor of Atlantic salmon distribution in the marine environment. Reddin and Shearer (1987) found that low SST appeared not only capable of deflecting Atlantic salmon from recognized migratory paths, but modified movements such that fish would avoid cold water even though warmer water was beyond. This avoidance behaviour was shown to affect fish habitat use during years when cold water extended south by forcing salmon to move further south as well (Reddin and Friedland 1993).

The 2010 COSEWIC Assessment and Status Report on Atlantic salmon outlines a total of 16 Atlantic salmon populations (COSEWIC 2010c) (Table 6.18). Each of these populations has been delineated in terms of natal river destination within Designatable Units (DU) (Figure 6.39). The general criteria used by COSEWIC to recognize DUs, and therefore populations, is groups of individuals likely exhibiting unique adaptations that are a component of the species' biodiversity (COSEWIC 2010c). Summary information regarding the Atlantic salmon population within each DU is provided primarily from COSEWIC (2010c) with updates since the COSEWIC assessment, where applicable. Each group has its own migration routes and overwintering patterns in marine waters.

Table 6.18 Atlantic Salmon Populations / Designatable Units and Their *SARA* and COSEWIC Status in the Western North Atlantic

Region	Population and Designatable Unit	*SARA*	COSEWIC
Nunavik and Labrador	Nunavik Population (DU1)	No Status	Data Deficient
	Labrador Population (DU2)	No Status	Not at Risk
Insular Newfoundland	Northeast Newfoundland Population (DU3)	No Status	Not at Risk
	South Newfoundland Population (DU4)	No Status	Threatened
	Southwest Newfoundland (Bay St. George Region) Population (DU5)	No Status	Not at Risk
	Northwest Newfoundland Population (DU6)	No Status	Not at Risk
Gulf of St. Lawrence	Quebec Eastern North Shore Population (DU7)	No Status	Special Concern
	Quebec Western North Shore (DU8)	No Status	Special Concern
	Anticosti Island (DU9)	No Status	Endangered
	Inner St. Lawrence (DU10)	No Status	Special Concern

Region	Population and Designatable Unit	*SARA*	COSEWIC
	Lake Ontario Population (DU11)	No status	Extinct
	Gaspe-southern Gulf of St. Lawrence (DU12)	No Status	Special Concern
Eastern – Southern Nova Scotia and Outer Bay of Fundy	Eastern Cape Breton (DU13)	No Status	Endangered
	Nova Scotia Southern Upland (DU14)	No Status	Endangered
	Outer Bay of Fundy (DU16)	No Status	Endangered
Inner Bay of Fundy	Inner Bay of Fundy (DU15)	Endangered	Endangered

Nunavik and Labrador Populations

Nunavik Population – Designatable Unit 1: The Nunavik population is within DU1 and is currently considered data deficient by COSEWIC (COSEWIC 2010c). Under *SARA*, this population is not listed. The DU extends from the tip of Labrador west along Ungava Bay to the western extent of the species range and represents the most northerly known population of Atlantic salmon in North America (COSEWIC 2010c). Genetic data suggest that the population is distinct from their nearest neighbour and there is little genetic evidence of straying between Ungava and other regions (COSEWIC 2010c).

Labrador Population – Designatable Unit 2: The Labrador population is within DU2 and is currently considered not at risk by COSEWIC (COSEWIC 2010c) and is not listed under *SARA* (Species at Risk Public Registry 2017). The DU extends from the northern tip of Labrador south along the coast of Labrador to the Napitipi River in Quebec. Given the large size of this geographic region there is substantial potential for smaller regional groupings within the DU, however the available information only supports a clear separation from other regions at the southern portion of the DU (COSEWIC 2010c). Genetic data suggest reasonable potential for gene flow and hence re-colonization throughout much of the southern portion of the unit. There is evidence from tagging studies, however, that salmon from the southern portion of this unit do not migrate north of Lake Melville.

Newfoundland Populations Including Southern Newfoundland

Northeast Newfoundland Population - Designatable Unit 3: The Northeast Newfoundland population is within DU3 and is currently considered not at risk by COSEWIC (COSEWIC 2010c) and is not listed under *SARA* (Species at Risk Public Registry 2017). The DU extends from the northern tip of Newfoundland south and east along the northeast coast of the Island to the southeast tip of the Avalon Peninsula (COSEWIC 2010c). The salmon of the northeast coast of Newfoundland are unique in North America, in that they appear to have genetic profiles intermediate to European and North American salmon. Mean age of smoltification was intermediate between Labrador and the rest of Newfoundland (3-5 years versus 5-7 in Labrador and 2-4 in southern Newfoundland DUs). The proportion of grilse that were smaller 1SW females was relatively high as was the incidence of repeat spawners. The Exploits and Terra Nova Rivers were stocked extensively in the 1980s and 1990s after new habitat was made accessible with fishways.

South Newfoundland Population - Designatable Unit 4: The South Newfoundland population is within DU4 and is currently considered threatened by COSEWIC (COSEWIC 2010c) and listed as no status under *SARA* (Species at Risk Public Registry 2017). The DU extends from the southeast tip of the Avalon Peninsula (Mistaken Point) westward along the south coast of Newfoundland to Cape Ray. Unlike DU3, freshwater habitat in DU4 tends to have relatively low pH values (5.0-6.0). Genetic data suggest that populations along this coast have reduced gene flow among local rivers and between DU4 and other regions of the Island (COSEWIC 2010c). Salmon in DU4 experience substantially different ocean conditions than fish in DUs 2-3, entering an area influenced by the Gulf Stream compared to the Labrador Current (COSEWIC 2010c). Population trends for south coast rivers also appear to be distinct from the other DUs in Newfoundland.

Southwest Newfoundland (Bay St. George Region) Population – Designatable Unit 5: The Southwest Newfoundland population is within DU5 and is currently considered not at risk by COSEWIC (COSEWIC 2010c) and is not listed under *SARA* (Species at Risk Public Registry 2017). The DU extends from Cape Ray northwards along the west coast of Newfoundland to approximately 40^{o} 24'N, 58^{o} 15' W. This DU is the only region in insular Newfoundland with large numbers of MSW salmon and minimal lacustrine habitat. Genetic comparisons of populations in this region with those in the rest of the Island suggest the populations here represent a distinct group, but that within the region gene flow appears to be higher than in DUs 3 and 4. DU5 also has the youngest mean smolt ages (3 years) on insular Newfoundland and the lowest proportion of female grilse (COSEWIC 2010c). DU5 is separated from mainland DUs by the Gulf of St. Lawrence and genetic data suggest low levels of gene flow between insular populations and the mainland (COSEWIC 2010c).

Northwest Newfoundland Population – Designatable Unit 6: The Northwest Newfoundland population is within DU6 and is currently considered not at risk by COSEWIC (COSEWIC 2010c) and is not listed under *SARA* (Species at Risk Public Registry 2017). The DU extends from approximately 40o 24'N, 58o 15' W to the tip of the Great Northern Peninsula. Smolts from populations of DU6 most likely migrate northward through the Strait of Belle Isle (COSEWIC 2010c). Freshwater habitat in DU6 is significantly more alkaline than the rest of insular Newfoundland due to a large amount of limestone in the region's geology (COSEWIC 2010c). Genetic data for this DU are sparse.

Gulf of St. Lawrence Populations

Quebec Eastern North Shore Population – Designatable Unit 7: The Quebec Eastern North Shore population is within DU7 and is currently listed as special concern by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). The DU extends from the Napitipi River (not inclusive) westward along the north shore of the St. Lawrence to the Kegaska River (inclusive) in the west. DU7 is characterized by populations with high proportions of 1SW salmon and rivers with lower temperature regimes than DU8. The genetic data also suggest these populations have lower levels of gene flow within the DU than within other areas of the North Shore (COSEWIC 2010c).

Quebec Western North Shore Population – Designatable Unit 8: The Quebec Western North Shore population is within DU8 and is currently considered special concern by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). The DU extends eastward from the Natashquan River (inclusive) along the Quebec North Shore to the Escoumins River in the west (inclusive). The salmon of DU8 have the highest proportion of MSW salmon by a wide margin relative

to the other populations in the North Shore DUs (COSEWIC 2010c) and stocking in this DU was substantial and has occurred in multiple rivers.

Anticosti Island Population – Designatable Unit 9: The Anticosti Island population is within DU9 and is currently considered endangered by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). The DU encompasses Anticosti Island.

Inner St. Lawrence Population – Designatable Unit 10: The Inner St. Lawrence population is within DU10 and is currently considered special concern by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). The DU extends west along the northern shore of the St. Lawrence from the Escoumins River (not included) into the lower St. Lawrence River and returns eastward along the southern shore of the St. Lawrence to the Ouelle River (included). DU10 is characterized by a higher proportion of 1SW salmon than the Quebec Western North Shore (DU8) and a lower mean age at smoltification. Freshwater habitat is also the warmest along the Quebec North Shore (COSEWIC 2010c).

Lake Ontario Population – Designatable Unit 11: The Lake Ontario population is within DU11 and is currently considered extinct by COSEWIC (COSEWIC 2010c) and has no status under *SARA* (Species at Risk Public Registry 2017). Approximately 67 tributaries of Lake Ontario were known to support runs of Atlantic salmon (COSEWIC 2010c). Scales obtained from two adult museum specimens indicate an exclusively freshwater growth history, suggesting that at least some salmon populations that originally inhabited Lake Ontario were freshwater resident and did not migrate to sea (COSEWIC 2010c). COSEWIC (2010c) suggests that Lake Ontario Atlantic salmon populations were likely reproductively isolated from other Atlantic salmon populations in North America.

Gaspe-southern Gulf of St. Lawrence Population – Designatable Unit 12: The Gaspe-southern Gulf of St. Lawrence population is within DU12 and is currently considered special concern by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). The DU extends from the Ouelle River (excluded) in the western Gaspe to the northern tip of Cape Breton. Genetic data are not available for Atlantic salmon on PEI; however, it is thought that salmon in small streams probably reflect the province's original populations, those in larger PEI streams are heavily influenced by stocking from eastern New Brunswick (COSEWIC 2010c). PEI has also provided salmon eggs for other rivers in the Maritimes and received substantial numbers of eggs and juveniles from mainland rivers; for most of this DU, stocking events have been common for at least the past 100 years (COSEWIC 2010c). For these reasons, PEI salmon are placed within DU12.

Eastern - Southern Nova Scotia and Outer Bay of Fundy Populations

Eastern Cape Breton Population – Designatable Unit 13: The Eastern Cape Breton population is within DU13 and is currently considered endangered by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). The DU extends from the northern tip of Cape Breton Island to northeastern Nova Scotia (approximately 45º 21'N, 61º 28'W). The salmon in this DU appear to be genetically distinct from its southern neighbour, DU14 (Nova Scotia Southern Upland).

Nova Scotia Southern Upland Population – Designatable Unit 14: The Nova Scotia Southern Upland population is within DU14 and is currently considered endangered by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). The DU extends from

northeastern mainland Nova Scotia (approximately 45º 21'N, 61º 28'W) southward and into the Bay of Fundy to Cape Split. Many rivers in DU14 have freshwater habitat with relatively low pH. They also have lower proportions of MSW fish than their northern neighbours. Southerly populations in DU14 also have some of the youngest smolt ages reported in Canada (COSEWIC 2010c). This DU also has an extensive history of stocking, including recent efforts to slow the decline of a few of the severely depressed populations in the DU.

Outer Bay of Fundy Population – Designatable Unit 16: The Outer Bay of Fundy population is within DU16 and is currently considered endangered by COSEWIC (COSEWIC 2010c) but has no status under *SARA* (Species at Risk Public Registry 2017). This DU extends westward from just east of the Saint John River estuary to the border with the United States (US). Within this DU, there is a higher proportion of MSW salmon migrating to the North Atlantic than DU15. While the DU terminates at the US border, from a biological perspective, the US populations may be included in the DU (COSEWIC 2010c).

Inner Bay of Fundy Population – Designatable Unit 15

The *Inner Bay of Fundy population* is within DU15 and is currently considered endangered by both COSEWIC (COSEWIC 2010c) and under *SARA* (Species at Risk Public Registry 2017). This DU extends from Cape Split around the Inner Bay of Fundy to a point just east of the Saint John River estuary. This DU has strong genetic differentiation from nearby DUs and appears to exhibit unique migratory behaviour (within the Bay of Fundy / Gulf of Maine (COSEWIC 2010c). Over 40 million salmon of differing ages have been stocked into rivers of this region since the turn of the 20th century. Early sources of stockings are unclear, but recent stocking has been done with Inner Bay of Fundy progeny (COSEWIC 2010c). Recent stocking events, intended to maximize exposure of salmon to wild environmental conditions are part of a captive-rearing program thought to have prevented, at least temporarily, the extinction of salmon in this DU (COSEWIC 2010c).

6.1.8.7 Atlantic Bluefin Tuna

Atlantic bluefin tuna are listed as endangered under COSEWIC. Critical habitat has not been established for this species and there are no known spawning or rearing habitats for early life stages of bluefin tuna in Canadian waters. This pelagic species migrates to Canadian waters in summer in search of food and move southward in the fall. Satellite tagging data indicates that Atlantic bluefin tuna occupy Canadian shelf waters from May to October in temperatures mainly ranging from 14-18ºC (Galuardi et al 2010). In Canadian waters Western Atlantic resident tuna are mainly distributed on the Scotian shelf whereas trans-Atlantic tuna occupy habitat areas from the Grand Banks, Flemish Pass, Flemish Cap and areas off the continental shelf (Walli et al 2009; COSEWIC 2011). Historical and current commercial fisheries are the main threats to this species (COSEWIC 2011). Juvenile and adult tuna feed opportunistically on pelagic and bottom fishes including capelin, saury, herring, mackerel and lanternfish (COSEWIC 2011).

6.1.8.8 Grenadier

Roundnose and roughhead grenadiers are listed as endangered and special concern, respectively, by COSEWIC. Distribution, biology and ecology for these species are described in Section 6.1.7. Critical habitat has not been established for the roundnose grenadier due to lack of information of habitat

associations in relation to life history stages (DFO 2010a). Critical habitat not been established for roughhead grenadier, however spawning grounds for this species are suggested to lie on the southern and southeastern slopes of the Grand Banks outside the Project Area (Scott and Scott 1988; COSEWIC 2007).

6.1.8.9 Atlantic Cod

Atlantic cod are listed as endangered by COSEWIC and details on distribution, biology and ecology for this species are described in Section 6.1.7. Currently no critical habitat has been established for Atlantic cod, however the Southeast Shoal and Tail of the Banks, Virgin Rocks and Burgeo Banks EBSAs are considered important spawning areas for cod (Templeman 2007).

6.1.8.10 White Hake

White hake are listed as threatened by COSEWIC. Distribution, biology and ecology for these species are described in Section 6.1.7 No critical habitat has been established for this species, however white hake have been observed to aggregate for foraging opportunities in the spring in the Laurentian Channel and Southwest Shelf Edge and Slope EBSAs (Templeman 2007; COSEWIC 2013; DFO 2016a).

6.1.8.11 Redfish

Acadian and deepwater redfish are listed as threatened by COSEWIC. Distribution, biology and ecology for these species are described in Section 6.1.7. To date, no critical habitats have been established for these species, however it has been suggested that habitats made up of anemones and coral beds may be linked to redfish survival (COSEWIC 2010d). The Southwest Shelf Edge and Slope is considered an important spawning area for redfish (Templeman 2007).

Figure 6.30 Distribution of Northern (Broadhead) Wolffish Based on Canadian RV Surveys (2008-2012)

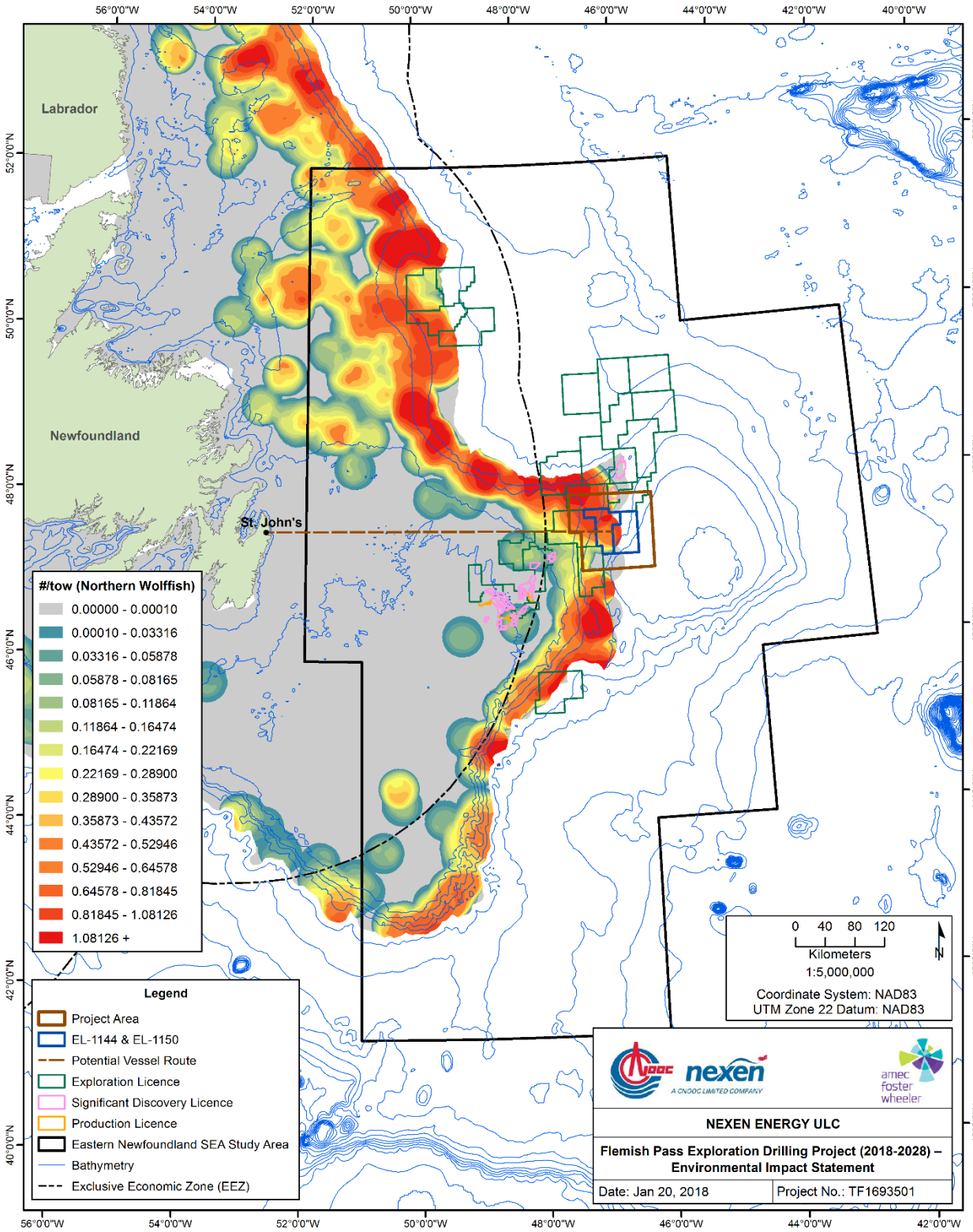


Figure 6.31 Distribution of Striped (Atlantic) Wolffish Based on Canadian RV Surveys (2008-2012)

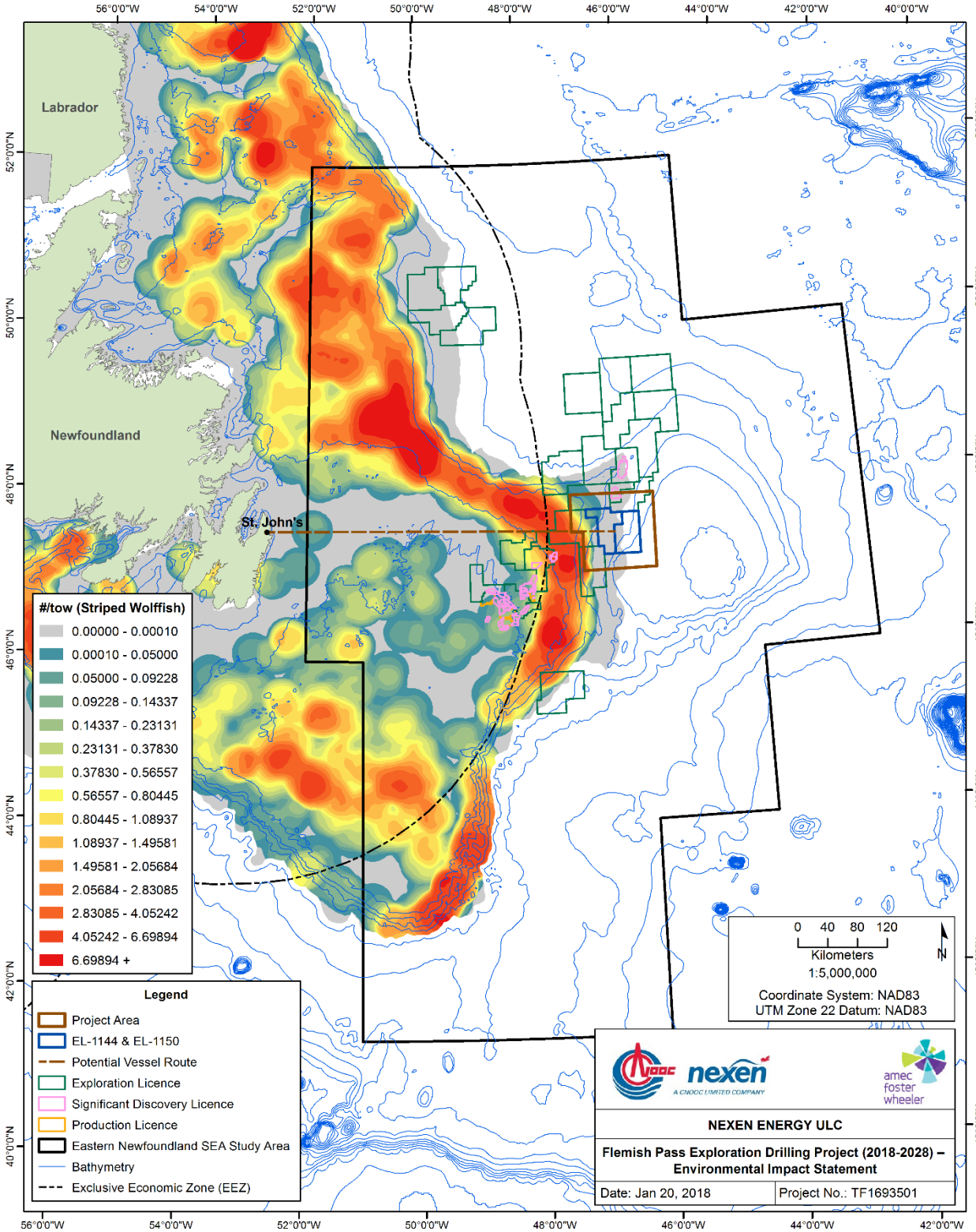


Figure 6.32 Distribution of Spotted Wolffish Based on Canadian RV Surveys (2008-2012)

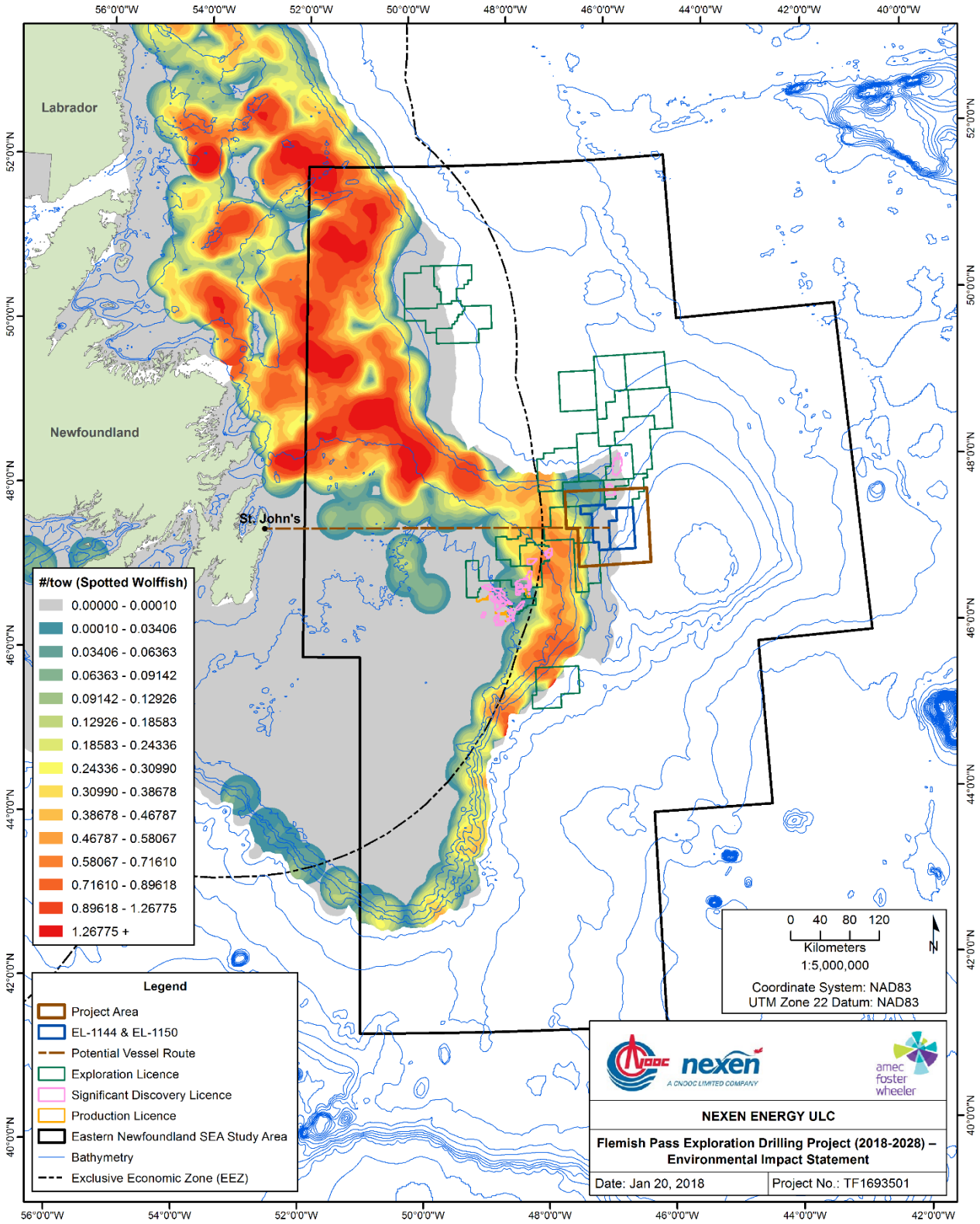


Figure 6.33 Generalized Migration Route of American Eels

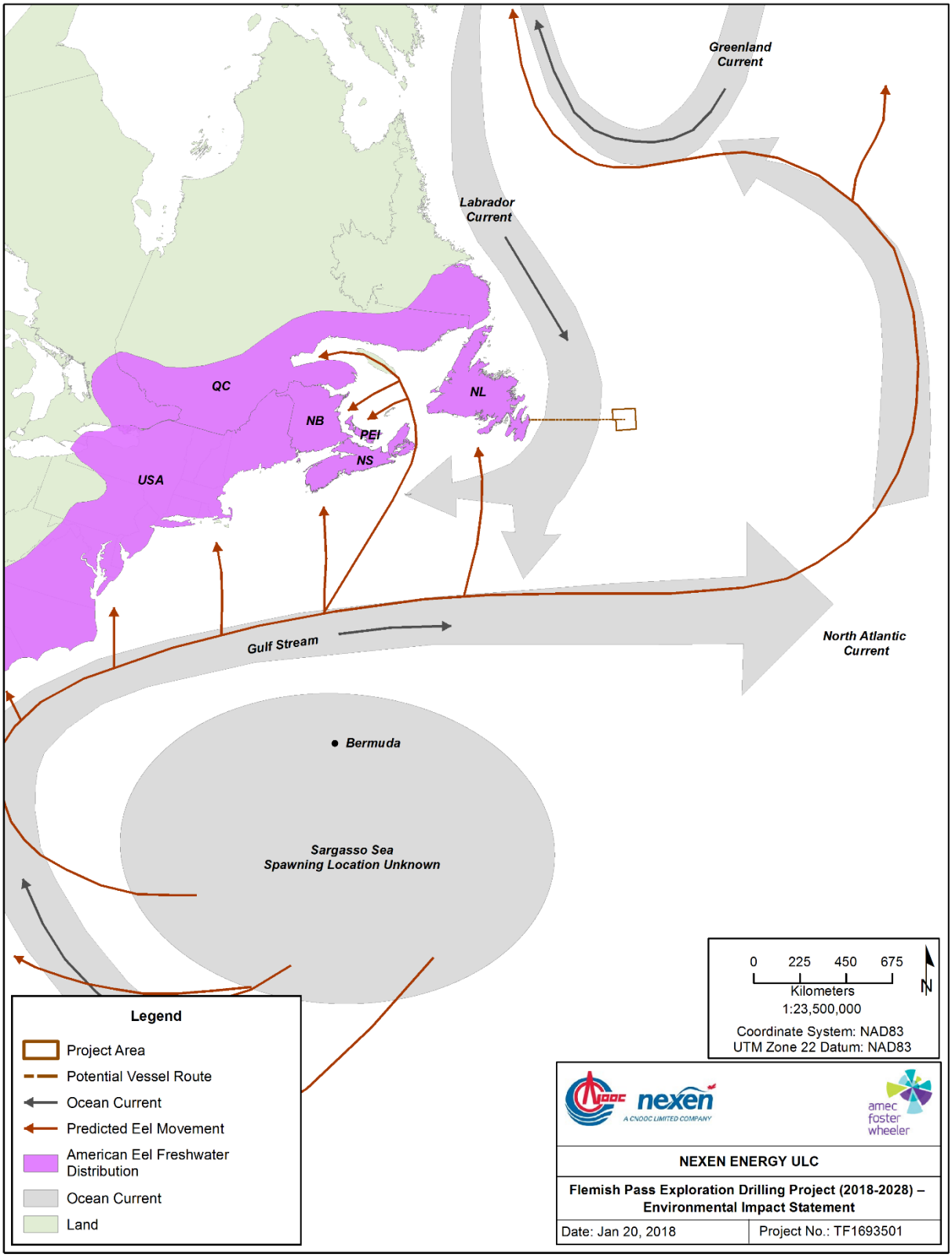
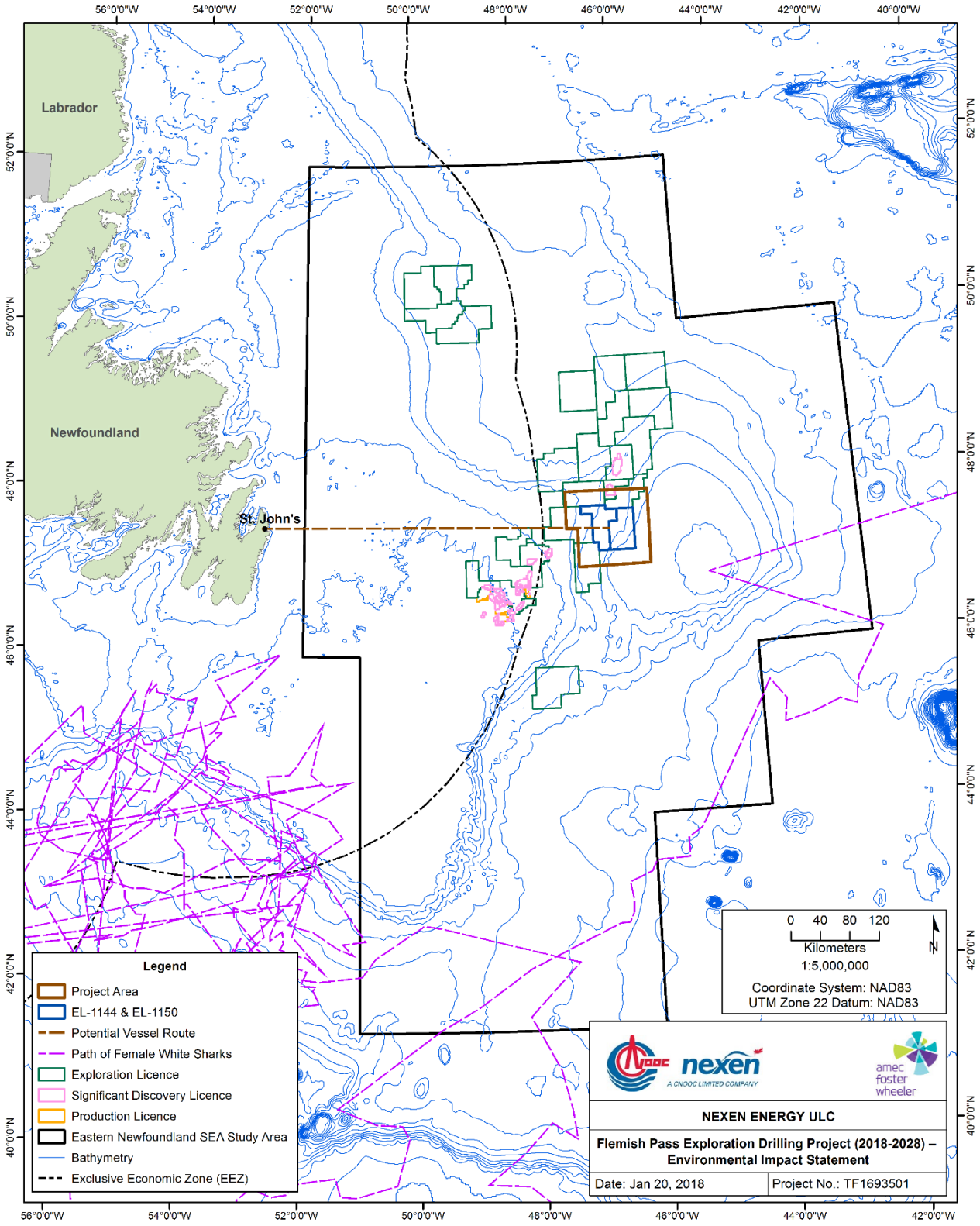


Figure 6.34 Migration Tracks of Female White Sharks



Source: Ocearch (2017)

Figure 6.35 Distribution of Thorny Skate Based on Canadian RV Surveys (2008-2012)

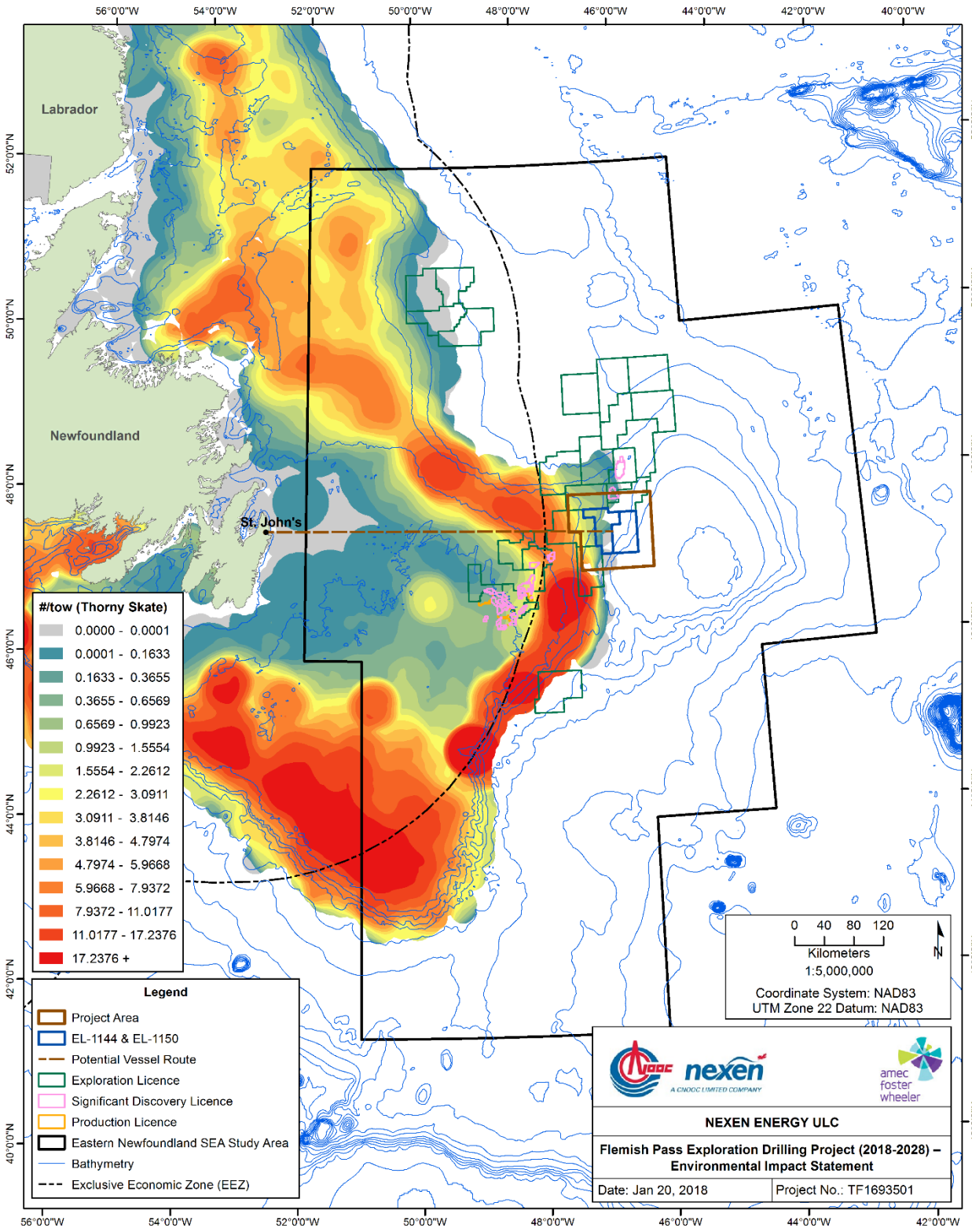


Figure 6.36 Atlantic Salmon: General Location of Currents and Summary Geographic Locations

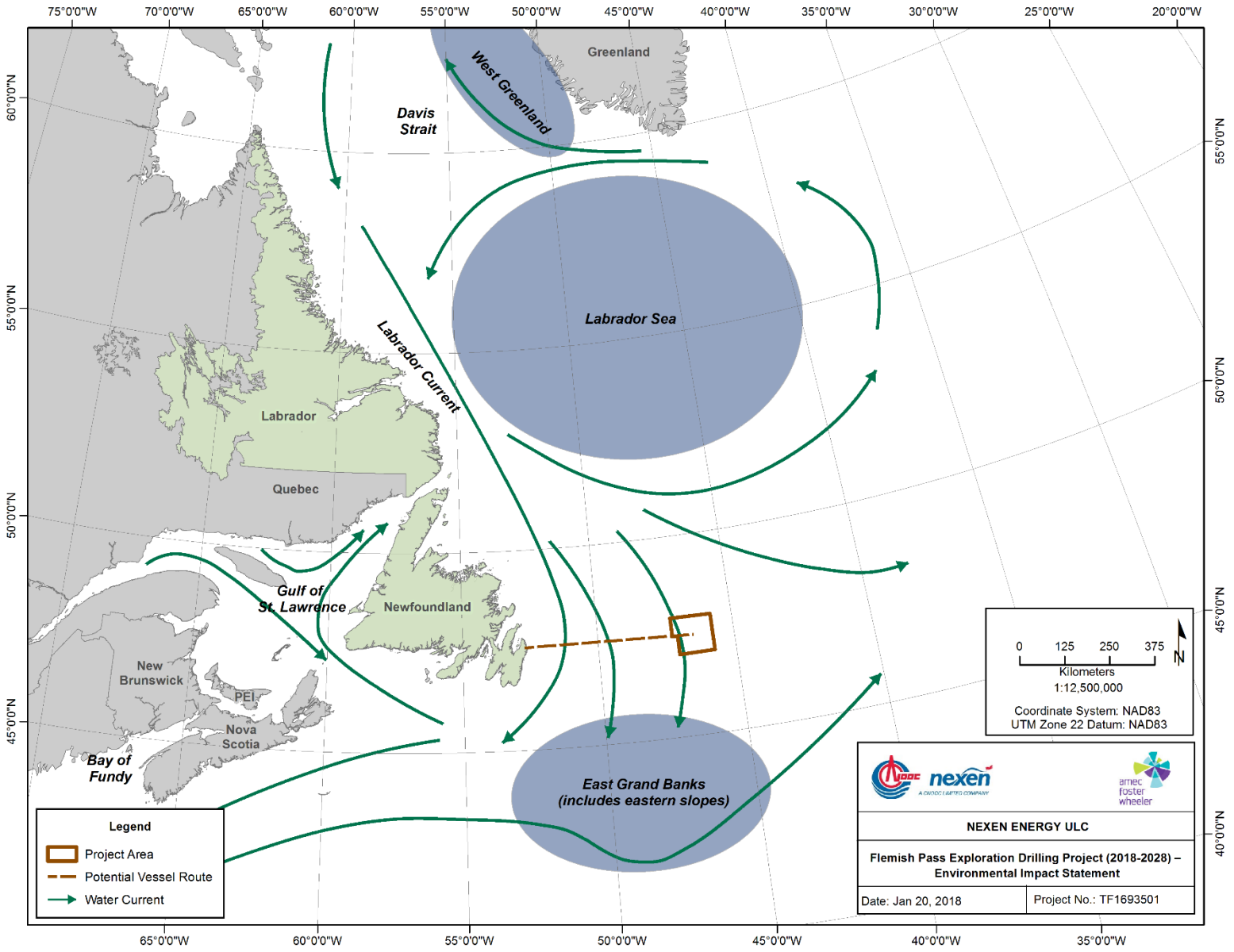


Figure 6.37 Atlantic Salmon Research Vessel Catches in the Northwest Atlantic Ocean (1965-1985)

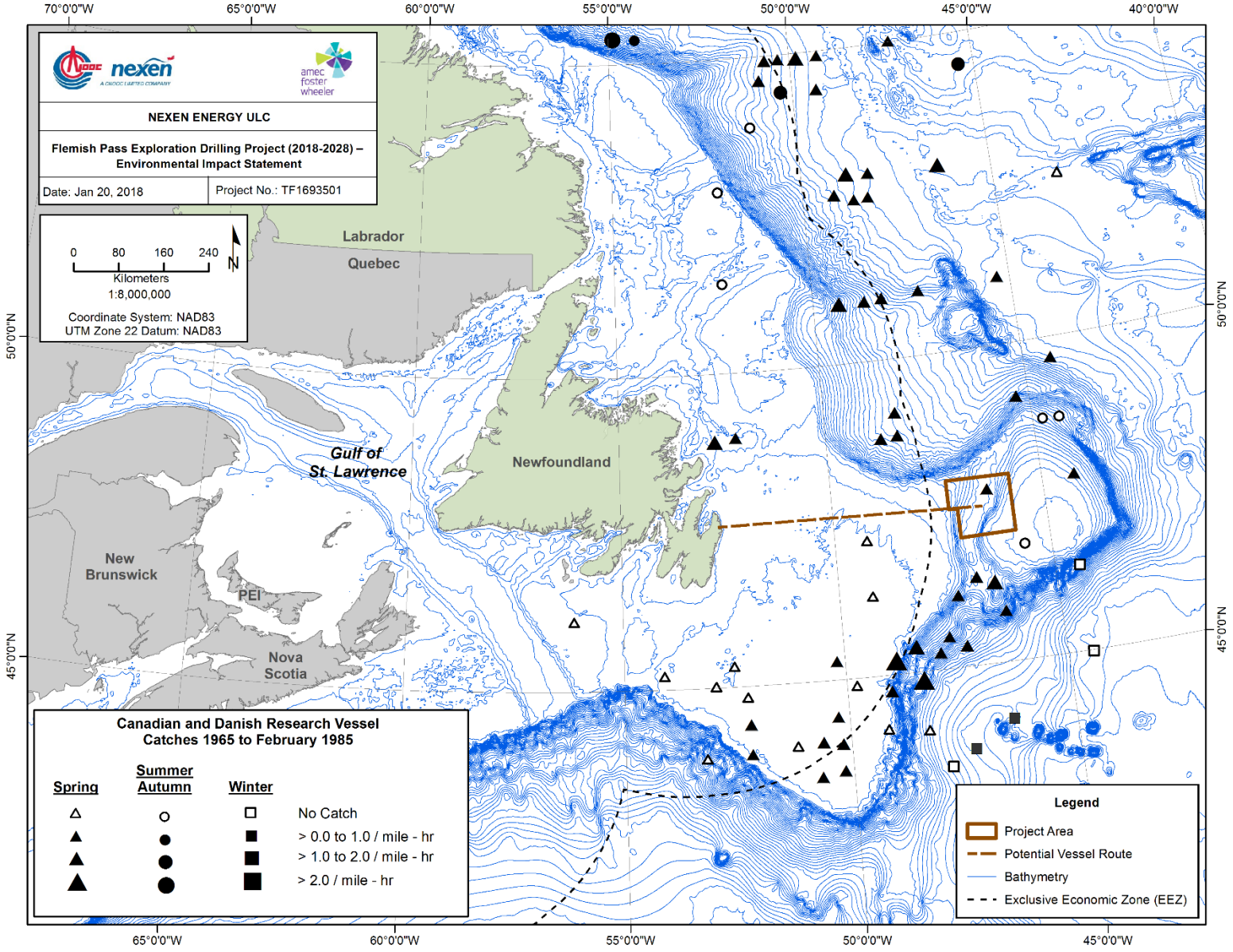
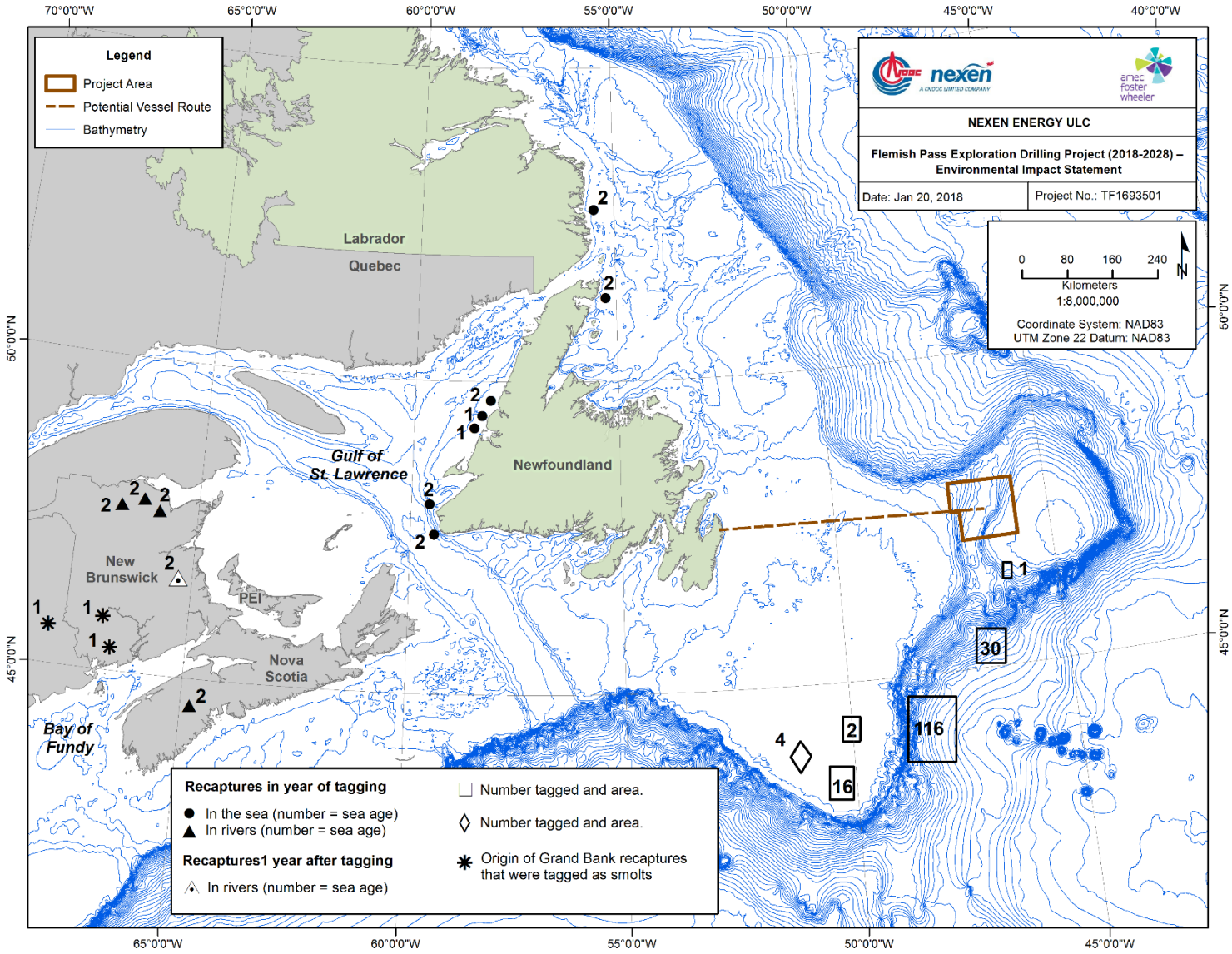
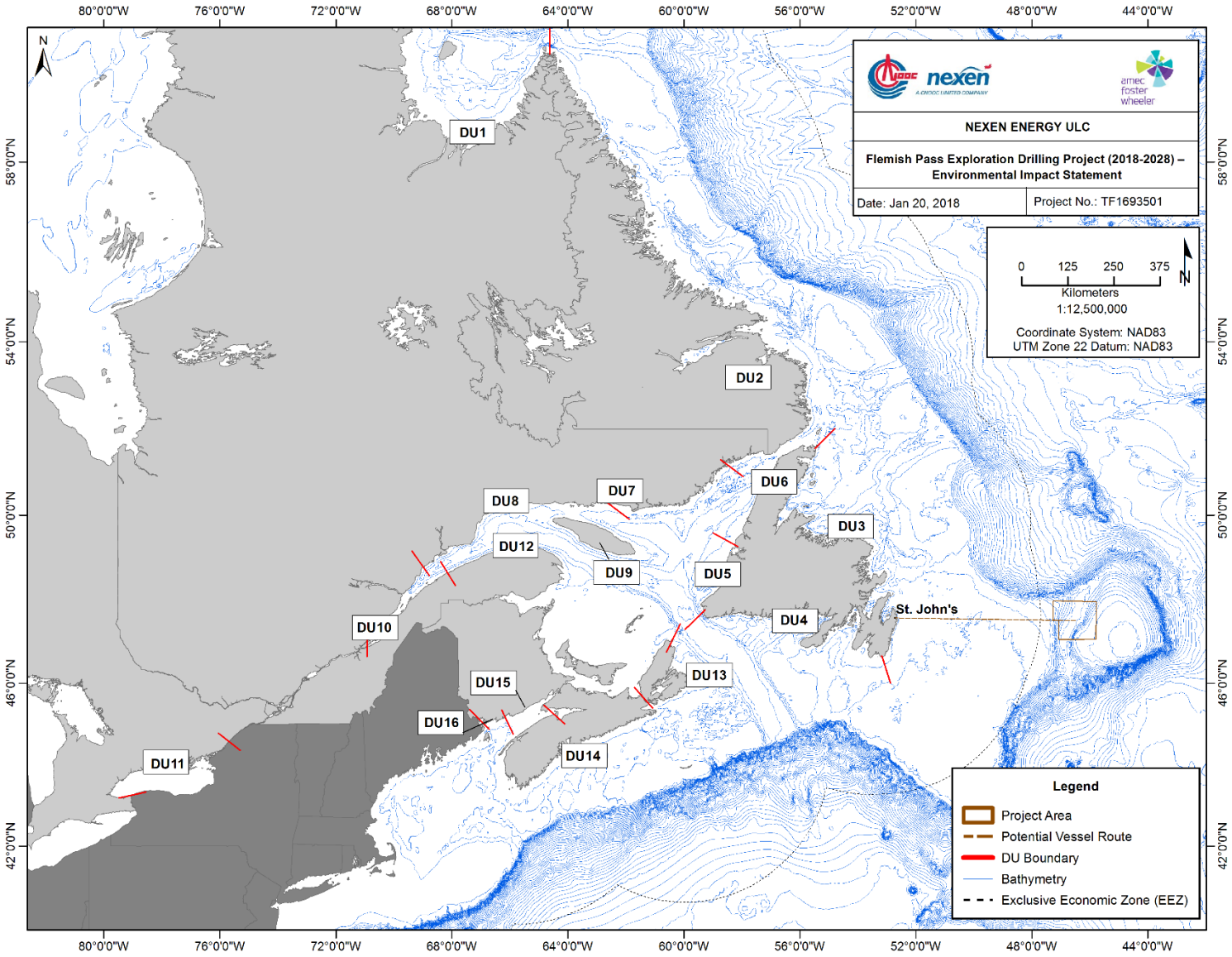


Figure 6.38 Numbers of Atlantic Salmon Tagged on and East of the Grand Banks (May 1979 and 1980), and Subsequent Recaptures in the Coastal Fishery and in Rivers



Source: Reproduced from Reddin (1985); Reddin and Shearer (1987)

Figure 6.39 Atlantic Salmon Designatable Units (DU) in Eastern Canada



Source: Reproduced from COSEWIC (2010c)

6.1.9 Aquatic Invasive Species

Invasive species threaten ecosystems around the globe (Molnar et al 2008, Cordes et al 2016). Their capacity for rapid population growth can disrupt ecosystems and their native species through processes that include predation, competition or habitat alteration. Such species can also have negative economic effects by affecting fisheries, fouling marine infrastructure and even altering human health (Molnar et al 2008). Consequently, invasive species are a concern to local fishers (Amec 2014), where increased industrial traffic serves as a potential vector for invasive species (McKenzie et al 2010; Benoît et al 2012, Cordes et al 2016). Seven invasive species have been identified in the Newfoundland and Labrador Shelf, including: the European green crab, the Japanese skeleton shrimp, the golden star tunicate, the violet tunicate, the vase tunicate, the coffin box bryozoans and oyster thief algae. These species are considered to have greater effects on benthic coastal communities compared to open ocean environments (Templeman 2010).

6.1.10 Identified Important and Sensitive Ecological Environments

A number of terrestrial, marine and coastal areas within and east of Newfoundland have been designated as protected under provincial, federal and/or other legislation and processes, or have been formally identified through relevant forums and processes as being otherwise special or sensitive due to their ecological, historical and/or socio-cultural characteristics and importance. Special areas with and adjacent to the Project Area and RSA are discussed and mapped in some detail in Section 6.4 of this EIS. Those that overlap with the Project Area that have particular relevance for marine fish and fish habitat are also identified and summarized below (Table 6.19).

Table 6.19 Identified Special Areas that Overlap with the Project Area and their Relationship to Marine Fish and Fish Habitat

Area Type	Area Name	Description as it Relates to Benthic Invertebrates and Finfish
NAFO Fisheries Closure Areas	Northwest Flemish Cap	• Northwest Flemish Cap (Area 10), • Northwest Flemish Cap (Area 11), • Closed to protect coral and sponge concentrations
	Flemish Pass/Eastern Canyon (Area 2)	• Closed to protect extensive sponge grounds
Source: NAFO (2014); NAFO (2015, 2016b, 2016c);		

6.1.11 Other Ecologically Important Habitats

Aggregate examinations of the fish communities from Canadian RV surveys also provide indication of ecologically important areas within the Project Area and RSA (Figures 6.40 to 6.42). For example, trawlable fish species richness was highest in the Flemish Pass and (surveyed areas of the) Cap as well as on the northern slope of the Grand Banks. Similarly, overall fish abundance and biomass was high in the Flemish Pass and the northern slope of the Grand Banks but the eastern Grand Banks slope was also important for measures of biomass. These areas are often coincident with other formally designated areas such as several EBSAs and fisheries closure / coral protection zones. In contrast, the shallow areas of the Grand Banks were relatively poor for all fish community measures, while the eastern slope of the Grand Banks was poor for richness and abundance. Other important areas, identified in previous SEAs (LGL 2003; Amec 2014) include the Frontal Extrusion Zone that is a high productivity zone located on the continental slope.

Figure 6.40 Overall Abundance of Organisms (Fish and Commercially Important Invertebrate Species) Inventoried from Canadian RV Trawl Survey Data (2008-2012)

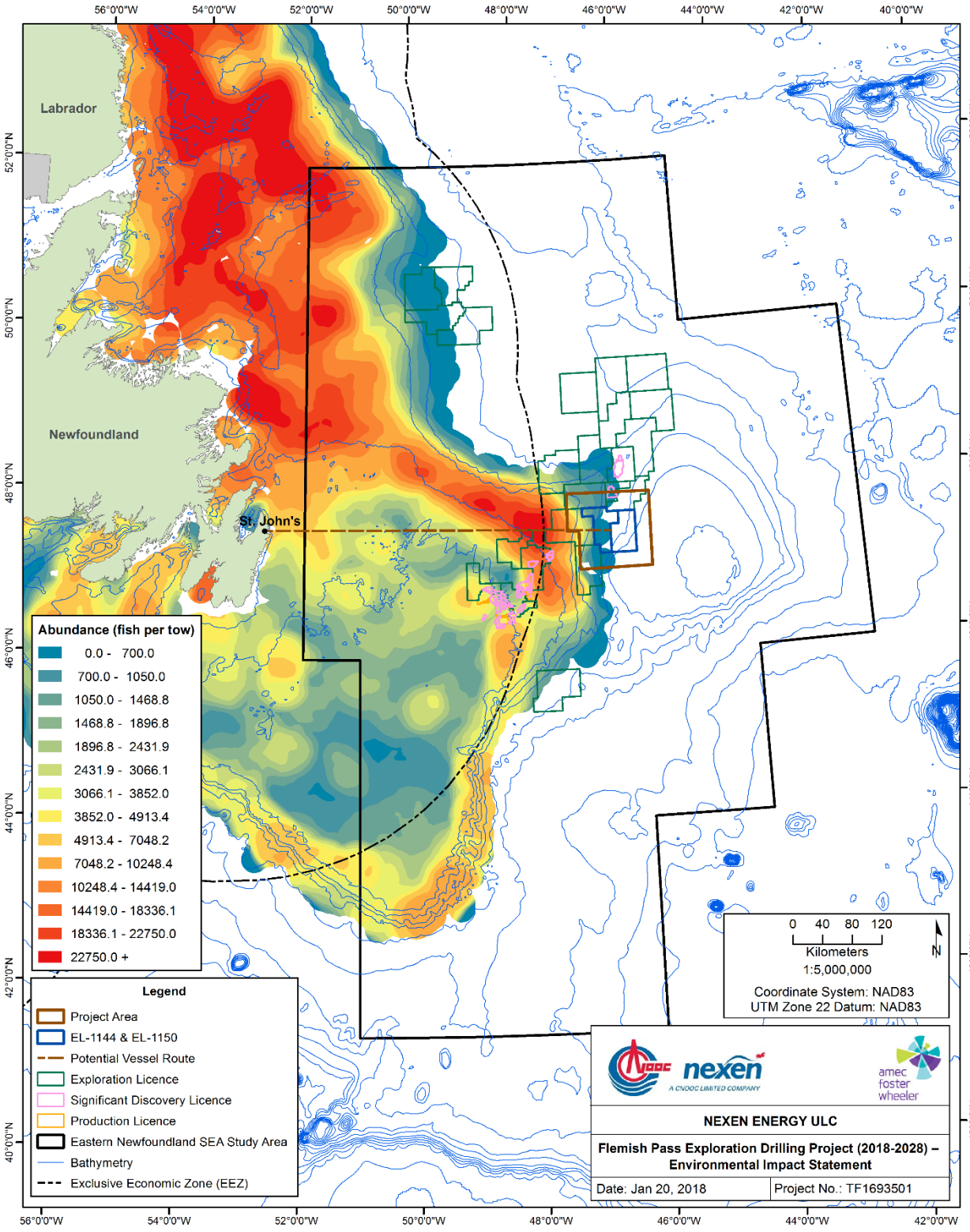


Figure 6.41 Total Species Richness (Fish and Commercially Important Invertebrate Species) Inventoried from Canadian RV Trawl Survey Data (2008-2012)

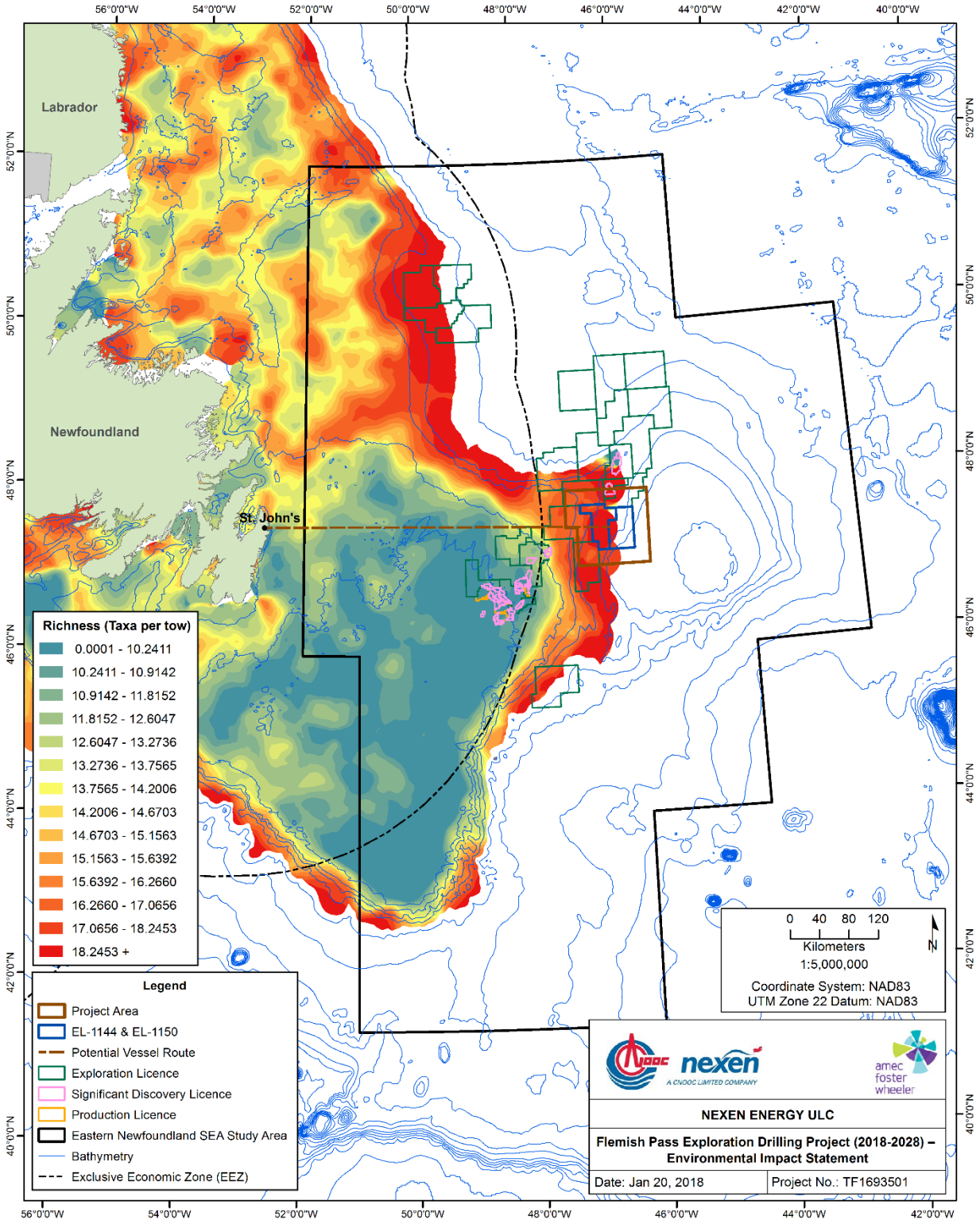
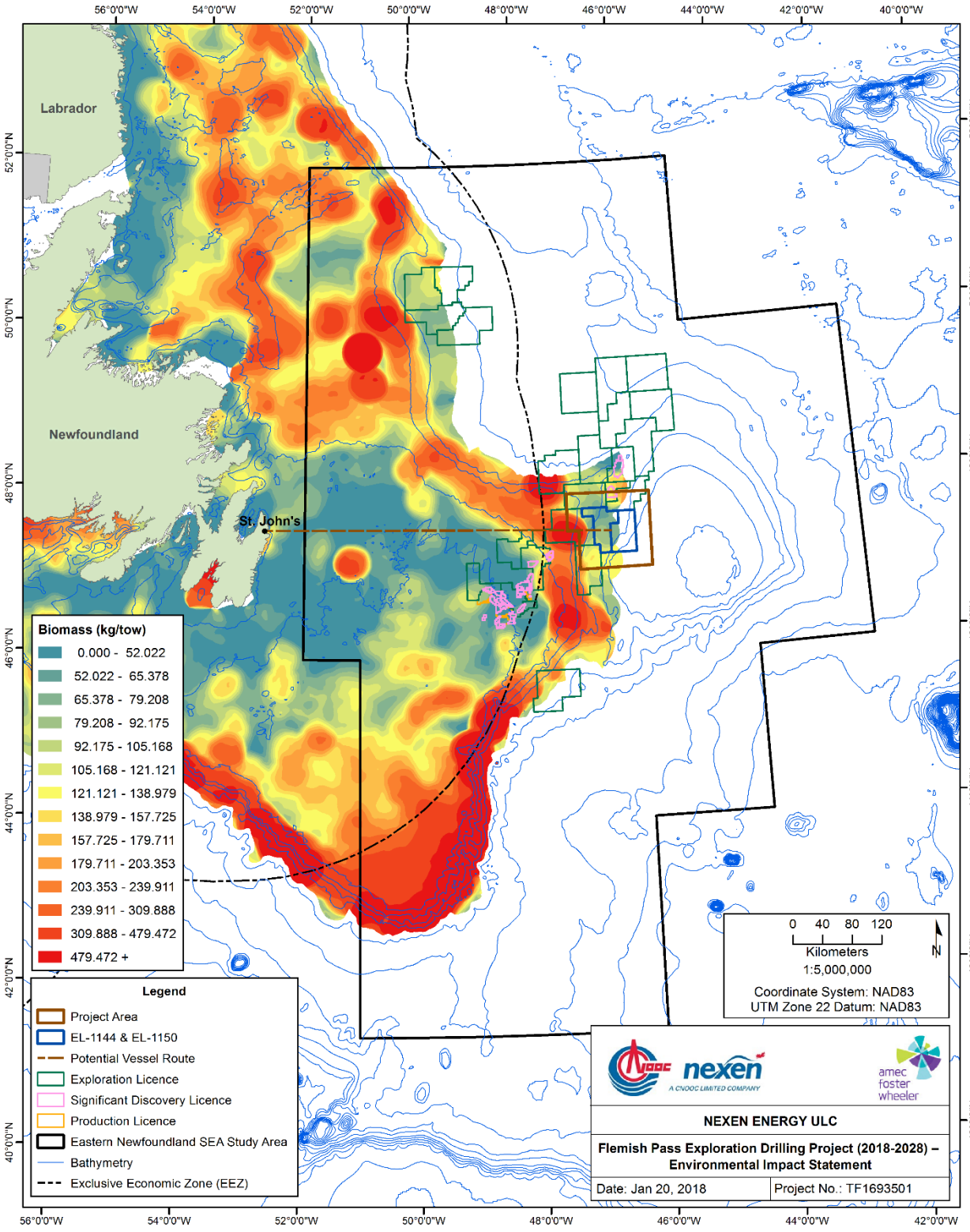


Figure 6.42 Total Biomass (Fish and Commercially Important Invertebrate Species) Inventoried from Canadian RV Trawl Survey Data (2008-2012)



6.2 Marine and Migratory Birds

As key components and indicators of ecosystem health, birds are often considered to be of high intrinsic ecological importance. Further, they are of socioeconomic importance in Newfoundland and Labrador both in terms of tourism (e.g. the Witless Bay and Cape St. Mary's Ecological Reserves), and as a food source (murres, known locally as "turrs", are hunted locally). The coastline of eastern and southern Newfoundland and Labrador, and the waters offshore, provide important habitat for various species of marine-associated birds. The nutrient-rich Grand Banks and Flemish Cap regions are important feeding areas for dozens of marine bird species, and are of particular importance to planktivorous species including storm-petrels, shearwaters and Dovekies due to the abundance of food in this area (Barrett et al 2006; Fort et al 2012, 2013). Offshore islands and mainland cliffs provide nesting grounds for tens of millions of seabirds representing some 20 species, including some of the largest seabird colonies in eastern North America south of the Hudson Strait (Lock et al 1994). Several Important Bird Areas (IBAs) have also been identified in Eastern Newfoundland, which have been designated as such because they provide important habitat for nationally and/or globally significant numbers of birds, and/or because they support avian species of conservation concern. In addition to the IBAs, there are several other sites of regional significance to migratory birds off Eastern Newfoundland.

Marine-associated birds that may occur within the Project Area and larger RSA can be generally divided into three categories: 1) seabirds, 2) waterfowl and divers, and 3) shorebirds. In addition, there are a number of landbird species that are associated with coastal habitats and/or migrate nocturnally over marine waters. The description that follows focusses primarily on the offshore Project Area, as it is within this area that Project-related interactions are most likely to occur.

6.2.1 Approach and Key Information Sources

The description of existing environmental conditions for marine and migratory birds is based primarily on the use of existing and available information and datasets. Information on avifauna presence and abundance was obtained from the Canadian Wildlife Service (CWS) branch of Environment and Climate Change Canada. This source was also consulted for information on seabird colonies in Eastern Newfoundland, as well as for recent data on seasonal and spatial trends in seabird abundance from the Eastern Canadian Seabirds at Sea (ECSAS) program. Records from the Atlantic Canada Shorebird Survey (ACSS) and the IBA of Canada programs were also accessed and used for the EIS. The existing information sources used are described and referenced throughout this chapter.

Because birds are highly mobile, and as much of the available survey data are collected in an opportunistic (not systematic) manner (e.g., from vessels of opportunity), any assessment of marine and migratory bird presence is inherently regional in scope. As illustrated in the sections that follow, however, these existing and available information sources provide a good, regional understanding of these existing conditions within the Project Area, LSA and RSA, which is considered adequate and appropriate for EA purposes.

Section 6.1.4 of the EIS Guidelines outlines the particular aspects of migratory birds and their habitats that are required to be described in the EIS, and in doing so, note for example that "the existing data must be supplemented by surveys, if required". Given the regional and often dynamic nature of avifauna presence and distributions across the Project Area, LSA and RSA, however, along with the overall logistical issues associated with undertaking bird surveys in this large offshore region, the value of

undertaking such surveys over the course of EIS preparation is questionable. This potential requirement for additional information on marine bird presence in the area is, however, being addressed through a key "post EIS" environmental monitoring commitment being made by Nexen as part of this EIS. In particular, and as described further in Section 9.6, Nexen will design and implement an operational monitoring program for marine birds throughout the course of the Project, and will report regularly on the results of this program to the relevant regulatory authorities. These results will both contribute to the overall knowledge base regarding marine avifauna presence and distributions in the region, as well as allowing for on-going discussions between Nexen and these agencies regarding Project-related activities, any apparent effects, and key mitigation measures. This information will also be incorporated and used in the annual EA Updates for the Project referenced in Section 18.4.

In addition to the summary text below, more detailed information (tables and figures) derived from these sources is provided in Appendix C.

6.2.2 Seabirds

Seabirds are relatively long-lived species with low fecundity, delayed recruitment and relatively low rates of population growth. A diverse assemblage of seabirds are found in the marine waters off Eastern Newfoundland (Table 6.20), including cormorants, gannets, phalaropes, gulls, terns, alcids (auks), jaegers and skuas, and tubenoses (fulmars, petrels and shearwaters). Many of these taxa nest along the coastline of Eastern Newfoundland. These avian taxa are discussed in turn below, and detailed accounts of each (including general life history information) can be found in Section 4.2.2.1 of the Eastern Newfoundland SEA (Amec 2014).

Table 6.20 Seabirds that are Known or Likely to Occur in the Project Area and RSA

Family	Species
Phalacrocoracidae – Cormorants	Great Cormorant (*Phalacrocorax carbo*)
	Double-crested Cormorant (*Phalacrocorax auritus*)
Suliidae – Gannets	Northern Gannet (*Morus bassanus*)
Scolopacidae – Phalaropes	Red Phalarope (*Phalaropus fulicarius*)
	Red-necked Phalarope (*Phalaropus lobatus*)
Laridae – Gulls	Herring Gull (*Larus argentatus*)
	Iceland Gull (*Larus glaucoides*)
	Glaucous Gull (*Larus hyperboreus*)
	Great Black-backed Gull (*Larus marinus*)
	Ring-billed Gull (*Larus delawarensis*)
	Black-headed Gull (*Chroicocephalus ridibundus*)
	Sabine's Gull (*Xema sabini*)
	Ivory Gull (*Pagophila eburnea*)
	Black-legged Kittiwake (*Rissa tridactyla*)
Sternidae – Terns	Common Tern (*Sterna hirundo*)
	Arctic Tern (*Sterna paradisaea*)
	Caspian Tern (*Hydroprogne caspia*)
Alcidae – Alcids	Dovekie (*Alle alle*)
	Razorbill (*Alca torda*)
	Common Murre (*Uria aalge*)
	Thick-billed Murre (*Uria lomvia*)
	Atlantic Puffin (*Fratercula arctica*)

Family	Species
	Black Guillemot (*Cepphus grylle*)
Stercorariidae – Jaegers and Skuas	Pomarine Jaeger (*Stercorarius pomarinus*)
	Parasitic Jaeger (*Stercorarius parasiticus*)
	Long-tailed Jaeger (*Stercorarius longicaudus*)
	Great Skua (*Stercorarius skua*)
	South Polar Skua (*Stercorarius maccormicki*)
Procellariidae – Fulmars and Shearwaters	Northern Fulmar (*Fulmarus glacialis*)
	Great Shearwater (*Ardenna gravis*)
	Sooty Shearwater (*Ardenna grisea*)
	Manx Shearwater (*Puffinus puffinus*)
	Cory's Shearwater (*Calonectris borealis*)
Hydrobatidae – Storm-petrels	Leach's Storm-petrel (*Oceanodroma leucorhoa*)
	Wilson's Storm-petrel (*Oceanites oceanicus*)
Note: Species at risk and species of conservation concern are shown in **bold** font.	

Fifield et al (2009) explored seasonal trends in abundance of seabirds off eastern Canada and found that the largest concentration of seabirds in the offshore waters of Eastern Newfoundland was from March to August, while seabirds were least abundant in the area in the fall (September - October). Data are relatively sparse for the fall months due to lack of survey coverage, but seabird abundance was consistent throughout the rest of the year with an average of approximately 18 to 25 birds / km^2 (Fifield et al 2009). The seasonal trends observed largely correspond with earlier PIROP (Programme Intégré des Recherches sur les Oiseaux Pélagiques) seabird survey data summarized in Lock et al (1994). In both of these data sets, the geographical survey coverage was considerably greater in the spring and summer months as compared to the fall and winter, as the survey program relies heavily on the use of vessels of opportunity rather than dedicated survey vessels.

ECSAS data from 2006 to 2017 were obtained from CWS, and while these survey data cannot be used to calculate densities as they have not been corrected for detectability (unlike the data in Fifield et al 2009), they provide valuable information on seasonal and spatial trends in abundance for the different seabird groups. Figures C.1 to C.13 in Appendix C were developed for taxa that were commonly observed in the ECSAS surveys to illustrate these survey data for the spring (March to April), summer (May to August), fall (September to October) and winter (November to February) seasons. The seasons as defined here are consistent with those used by Fifield et al (2009) and correspond to seabirds' migratory (spring and fall), breeding (summer for northern hemisphere breeders; winter for southern hemisphere breeders) and non-breeding (winter for northern hemisphere breeders; summer for southern hemisphere breeders) seasons.

6.2.2.1 Cormorants

Both Great and Double-crested Cormorants nest in Eastern Newfoundland and often form mixed colonies (Hatch et al 2000). They generally feed within a few kilometers of their colony or roost location and rarely venture far from the coast at any time of year, and so their abundance in the Project Area is low. ECSAS sightings for cormorants off Eastern Newfoundland, including the RSA, are presented in Figure C.1 (Appendix C). There was just one cormorant sighting more than 100 km from shore. Two sightings were identified as Great Cormorants, and the rest were not identified to species level. CWS records indicate that there are eight known cormorant colonies in Eastern Newfoundland (Table C.1 in Appendix C), although species composition was not determined.

6.2.2.2 Gannets

Northern Gannets nest in Eastern Newfoundland, and are most likely to be present in the area from spring to fall, as the majority of the population overwinters in the Gulf of Maine and further south (Mowbray 2002; Montevecchi et al 2012). However, they have been observed in the waters off Newfoundland at all times of year. ECSAS sightings for Northern Gannets are presented in Figure C.2 (Appendix C). CWS survey data for the two colonies of Northern Gannet in Eastern Newfoundland are presented in Table C.2 (Appendix C).

6.2.2.3 Phalaropes

Phalaropes breed in Arctic tundra during the summer months and typically overwinter south of Canada, occurring most frequently in the RSA during migration. The Red-necked Phalarope has been assessed by COSEWIC as a species of Special Concern. ECSAS sightings for phalaropes are presented in Figure C.3 (Appendix C), which shows that phalarope sightings were infrequent in summer and fall and even rarer in winter, and no sightings were reported in the region during the spring surveys. Although most of the sightings were not identified to species level, of those that were identified most were Red Phalarope which is known to be the more pelagic of the two species (Tracy et al 2002).

6.2.2.4 Gulls

Herring, Great Black-backed and Ring-billed Gulls and Black-legged Kittiwakes occur in temperate areas year-round, while Sabine's, Ivory, Iceland and Glaucous Gulls nest in the Arctic and are found in the RSA only outside the breeding season. Laughing, Black-headed and Lesser Black-backed Gulls may occur infrequently in the RSA. The Ivory Gull is listed as endangered under both *NL ESA* and *SARA*. Gulls breeding in the region have suffered population declines due to reduced food availability associated with the collapse of fisheries and the closure of municipal landfills, although recent census data indicates that populations are showing some signs of recovery (Cotter et al 2012). Outside of the breeding season, most gull species are associated with coastal areas, while Sabine's Gull, Ivory Gull and Black-legged Kittiwake are more pelagic. A tracking study of Black-legged Kittiwakes found that the northwest Atlantic, particularly the shelf edge off Newfoundland, is a particularly important wintering area for kittiwakes, with most of the Atlantic population overwintering in this region (Frederiksen et al 2012).

ECSAS sightings for Black-legged Kittiwakes and Large Gulls (i.e. all other gull species) within the RSA are presented in Figures C.4 and C.5, respectively, in Appendix C. As illustrated, gulls and kittiwakes were both commonly observed in the area year-round. Most of the large gulls identified to species level were Great Black-backed Gull, Herring Gull, and in the winter months, Iceland Gull and Glaucous Gull. No endangered Ivory Gulls were identified in the ECSAS surveys.

Newfoundland supports more than two-thirds of Atlantic Canada's breeding gull population, with Black-legged Kittiwakes accounting for almost half of this number (Cotter et al 2012). CWS records of gull colonies in Eastern Newfoundland are shown in Table C.3 (Appendix C), and the colony locations are shown later in Figure 6.44. Herring Gull, Great Black-backed Gull and Black-legged Kittiwake colonies are abundant and widespread along the coast, while Ring-billed Gull colonies are fewer in number.

6.2.2.5 Terns

All three tern species found in the Project Area and RSA are migratory, and are present only during the breeding season. Terns are typically found in coastal environments, seldom seen far from shore except for Arctic Terns which tend to be highly pelagic during migration (Cuthbert and Wires 1999; Hatch 2002; Nisbet 2002). ECSAS sightings for terns are presented in Figure C.6 (Appendix C). They were infrequently observed in the spring and summer, and essentially absent in the fall and winter. While most tern sightings could not be identified to species level, both Common and Arctic Terns have been observed in the waters of Eastern Newfoundland in the ECSAS surveys. CWS records for tern colonies in Eastern Newfoundland are provided in Table C.4 in Appendix C; species composition of the colonies was not reported.

6.2.2.6 Alcids

Five of the six alcid species found in the Project Area and RSA breed in Eastern Newfoundland, while the Dovekie is a largely Arctic-nesting species. During breeding, they are most abundant in the waters near the colonies. Among seabirds, murres and Dovekies spend a particularly large proportion of their time on the water relative to more aerial species (Wiese and Ryan 2003; Wilhelm et al 2007; Fifield et al 2009) and congregate over relatively small, productive areas such as around the Grand Banks (Gaston et al 2011; Hedd et al 2011; Montevecchi et al 2012). The core winter distribution of the world's Dovekie population lies within the waters off Eastern Newfoundland (Fort et al 2013). Most of the Eastern Canadian population of Common Murres and over a third of the region's Thick-billed Murres also congregate in this region in the winter months (McFarlane Tranquilla et al 2013). Alcids are rendered flightless for several weeks each year during the fall moulting period (Gaston and Hipfner 2000; Ainley et al 2002; Montevecchi and Stenhouse 2002; Lavers et al 2009). Atlantic Puffins tend to disperse widely and well offshore in the winter months (Fifield et al 2009), while Razorbills are believed to concentrate in the Bay of Fundy in winter (Huettman et al 2005), and Black Guillemots tend to be associated with coastal environments year-round (Butler and Buckley 2002).

ECSAS sightings for alcids are presented in Appendix C, Figure C.7 (Dovekies), Figure C.8 (Murres) and Figure C.9 (Other alcids, including Razorbills, Black Guillemots and Atlantic Puffins). All six species have been reported in ECSAS surveys year-round, although Black Guillemots are relatively infrequently observed. The eastern coast of Newfoundland supports numerous alcid colonies, the largest at Funk Island, Baccalieu Island, the Witless Bay islands and Cape St. Mary's. CWS records for alcid colonies in Eastern Newfoundland are provided in Table C.5 (Appendix C).

6.2.2.7 Jaegers and Skuas

Five species of jaegers and skuas occur regularly in the Project Area and RSA, none of which breed in Newfoundland. Pomarine, Parasitic and Long-tailed Jaegers breed in high Arctic tundra, South Polar Skuas nest along the Antarctic coast, and Great Skuas on coastal moors and rocky islands in Europe. Non-breeders are found offshore year-round, while breeding adults attend the colonies in the summer. Outside of the breeding season, jaegers and skuas typically feed by kleptoparasitizing (stealing) prey items from other seabirds (Wiley and Lee 1998, 1999, 2000). In the winter months, the waters off eastern Canada support a large proportion of the Icelandic population of Great Skuas (Magnusdottir et al 2012). ECSAS sightings for jaegers and skuas are presented in Figure C.10 (Appendix C). While most sightings could not be identified to species level, all five have been observed in the waters off

Eastern Newfoundland. Great Skuas were much more numerous than South Polar Skuas, and Pomarine Jaegers were identified more often than Parasitic or Long-tailed Jaegers.

6.2.2.8 Fulmars and Shearwaters

Northern Fulmar and Manx Shearwater nest in Newfoundland (Lee and Haney 1996; Mallory et al 2012), while the other three species of shearwater (Great, Sooty and Cory's) do not. Outside the breeding season, fulmars and shearwaters are highly pelagic and spend most of their time in the air, at or near the water's surface. The Northern Fulmar is common year round in the offshore waters of Eastern Newfoundland. Shearwaters are most common overall in offshore Newfoundland in the summer and fall months, particularly on the east and northeast Grand Banks (Fifield et al 2009). Most of the world's population of Great Shearwaters is found in the northwest Atlantic in the summer months, outside of their austral breeding season (Brown 1986).

ECSAS sightings for fulmars and shearwaters are presented in Figures C.11 and C.12, respectively, in Appendix C. Of the shearwaters that could be identified in the surveys, Great Shearwater was the most commonly identified species in the RSA, followed by Sooty, Manx and Cory's. CWS records for Northern Fulmar colonies in Eastern Newfoundland are provided in Table C.6 in Appendix C. The Manx Shearwater is known to nest in one small colony, at Middle Lawn Island off the Burin Peninsula, which is the only known regular nesting site in North America (Lee and Haney 1996).

6.2.2.9 Storm-petrels

The Leach's Storm-petrel is the most abundant breeding seabird in Newfoundland, while the Wilson's Storm-petrel is an Antarctic breeder and uncommon visitor in the northwest Atlantic. Storm-petrels are highly pelagic, often following ships and fishing boats, and are attracted to artificial light sources (Huntington et al 1996). Leach's Storm-petrel is the species most frequently found stranded on platforms and vessels in and near the RSA (Ellis et al 2013; Environment Canada 2015), with the vast majority of strandings occurring in September and October, corresponding with the departure of fledglings from the breeding colonies (Huntington et al 1996). The largest Leach's Storm-petrel colony in the world, Baccalieu Island, supports approximately one third of the species' population (Huntington et al 1996; Barrett et al 2006; CWS 2017). ECSAS sightings for storm-petrels are presented in Figure C.13 (Appendix C). They are commonly observed in the summer months and regularly seen in the spring and fall, but are uncommon in winter. CWS records for Leach's Storm-petrel colonies in Eastern Newfoundland are provided in Table C.7 (Appendix C).

6.2.3 Waterfowl and Divers

Waterfowl and divers (loons and grebes) spend much of their time on the water's surface. Although loons and grebes are not waterfowl, they are behaviourally and functionally similar, and have therefore been combined in this section. Broadly, waterfowl may be categorized as geese and ducks; the latter includes dabbling ducks (primarily inland breeders), diving ducks, and sea ducks. Most species of sea ducks spend much of the year at sea (generally close to shore). Waterfowl occur in large numbers in marine habitats off Eastern Newfoundland, especially during the winter months, although they tend to prefer more coastal habitats and are unlikely to occur frequently in the Project Area or RSA. Several species of waterfowl and divers occur in the province during at least part of the year (Table 6.21); of these species, the sea ducks (Merginae) and loons (Gaviidae) have the highest potential to occur in the

RSA; geese, dabbling ducks, diving ducks and grebes are less likely to be found offshore. Two waterfowl species of conservation concern are found in the waters off Eastern Newfoundland, the Barrow's Goldeneye (*NL ESA*: Vulnerable; *SARA*: Special Concern) and Harlequin Duck (*NL ESA*: Vulnerable; *SARA*: Special Concern).

Table 6.21 Overview of Waterfowl and Divers that have Potential to Occur in the Project Area and RSA

Family	Species
Anserinae – Geese	Canada Goose (*Branta canadensis*)
Anatinae – Dabbling Ducks	Wood Duck (*Aix sponsa*)
	Gadwall (*Anas strepera*)
	Eurasian Wigeon (*Anas penelope*)
	American Wigeon (*Anas americana*)
	American Black Duck (*Anas rubripes*)
	Mallard (*Anas platyrhynchos*)
	Blue-winged Teal (*Anas discors*)
	Northern Shoveler (*Anas clypeata*)
	Northern Pintail (*Anas acuta*)
	Green-winged Teal (*Anas crecca*)
Aythyinae – Diving Ducks	Ring-necked Duck (*Aythya collaris*)
	Tufted Duck (*Aythya fuligula*)
	Greater Scaup (*Aythya marila*)
	Lesser Scaup (*Aythya affinis*)
Merginae – Sea Ducks	King Eider (*Somateria spectabilis*)
	Common Eider (*Somateria mollissima*)
	Harlequin Duck (Eastern pop.) (*Histrionicus histrionicus*)
	Surf Scoter (*Melanitta perspicillata*)
	White-winged Scoter (*Melanitta fusca*)
	Black Scoter (*Melanitta americana*)
	Long-tailed Duck (*Clangula hyemalis*)
	Bufflehead (*Bucephala albeola*)
	Common Goldeneye (*Bucephala clangula*)
	Barrow's Goldeneye (Eastern pop.) (*Bucephala islandica*)
	Hooded Merganser (*Lophodytes cucullatus*)
	Common Merganser (*Mergus merganser*)
	Red-breasted Merganser (*Mergus serrator*)
Gaviidae – Loons	Red-throated Loon (*Gavia stellata*)
	Common Loon (*Gavia immer*)
Podicipedidae – Grebes	Pied-billed Grebe (*Podilymbus podiceps*)
	Red-necked Grebe (*Podiceps grisegena*)
Note: Species at risk and species of conservation concern are shown in **bold** font.	

The most abundant species of waterfowl in coastal Newfoundland waters at all times of year is the Common Eider, which breeds in several small colonies along the coast (Locke et al 1994). Common Eiders and other sea ducks such as scoters and Long-tailed Ducks occur in large flocks ("rafts") off the coast from autumn to spring. Large wintering congregations occur at Witless Bay IBA, between the Cape Freels coastline and nearby Wadham Islands, Grates Point, Cape St. Francis, Mistaken Point, Cape St. Mary's and Placentia Bay (Bird Studies Canada 2017). Small numbers of Barrow's Goldeneye have been reported wintering in Eastern Newfoundland at Port Blandford and Newman Sound in Terra Nova National Park, as well as Traytown Bay, St. Mary's Bay, and Spaniard's Bay (Schmelzer 2006).

ECSAS sightings for waterfowl and divers are presented in Figure C.14 (Appendix C). Waterfowl observations were scarce in the waters off Eastern Newfoundland, but the most frequently observed species was Common Eider, followed by Long-tailed Duck; loons (Common and Red-throated), scoters (White-winged, Surf and Black) and a handful of other waterfowl species were infrequently observed.

6.2.4 Shorebirds

Marine shoreline habitats such as sandy mudflats and coastal barrens are utilized by foraging shorebirds during migration, but shorebirds are not typically found offshore. As the planned Project activities will take place offshore, several hundred kilometers from the coastline, it is unlikely that shorebirds will occur in the area with any regularity, other than phalaropes (which are taxonomically shorebirds but due to their pelagic habitat preferences are discussed along with the seabirds in this report) nor would migrating landbirds. Due to their preference for coastal habitats, shorebirds are very infrequent visitors to the area, primarily in the fall months during migration. More than 25 species of shorebirds occur in the province for at least part of the year and may pass through the offshore components of the RSA (Table 6.22). Least Sandpiper, Spotted Sandpiper, Greater Yellowlegs, Piping Plover, Semipalmated Plover and Killdeer nest in Newfoundland, while others are present only during migration (Warkentin and Newton 2009).

On the southern and eastern coasts of Newfoundland, shorebirds are most abundant during their fall migration, when many species move southward from their Arctic breeding grounds. Atlantic Canada Shorebird Survey data show that the eastern coast of the Avalon Peninsula has several important migration stopovers (e.g., Witless Bay, Renews, Long Beach, St. Shotts, Spaniard's Bay, Bellevue Beach, etc.); other major stopovers in southern and Eastern Newfoundland include Big Barasway, Grand Bay West to Cheeseman Provincial Park, Codroy Valley Estuary, Cape Freels and Cape Bonavista (Environment Canada 2009; Bird Studies Canada 2017). In the winter months, generally from November to April, Purple Sandpipers are present along rocky shorelines and offshore ledges and islands of Southern and Eastern Newfoundland, including at Cape Spear, Witless Bay, Ferryland, Cape St. Francis and Mistaken Point in Eastern Newfoundland (Environment Canada 2009; Bird Studies Canada 2017). At Mistaken Point, far north of the rest of the species' usual wintering range, a small number of Ruddy Turnstones regularly overwinter (Bird Studies Canada 2017).

Table 6.22 Overview of Shorebirds that have Potential to Occur in the Project Area and RSA

Family	Species
Charadriidae – Plovers	Black-bellied Plover (*Pluvialis squatarola*)
	American Golden-Plover (*Pluvialis dominica*)
	Semipalmated Plover (*Charadrius semipalmatus*)
	Piping Plover (*melodus* ssp.) (*Charadrius melodus*)
	Killdeer (*Charadrius vociferus*)
Scolopacidae – Sandpipers	Spotted Sandpiper (*Actitis macularius*)
	Solitary Sandpiper (*Tringa solitaria*)
	Greater Yellowlegs (*Tringa melanoleuca*)
	Willet (*Tringa semipalmata*)
	Lesser Yellowlegs (*Tringa flavipes*)
	Whimbrel (*Numenius phaeopus*)
	Hudsonian Godwit (*Limosa haemastica*)
	Ruddy Turnstone (*Arenaria interpres*)
	Red Knot (*rufa* ssp.) (*Calidris canutus*)
	Sanderling (*Calidris alba*)
	Semipalmated Sandpiper (*Calidris pusilla*)
	Least Sandpiper (*Calidris minutilla*)
	White-rumped Sandpiper (*Calidris fuscicollis*)
	Baird's Sandpiper (*Calidris bairdii*)
	Pectoral Sandpiper (*Calidris melanotos*)
	Purple Sandpiper (*Calidris maritima*)
	Dunlin (*Calidris alpina*)
	Stilt Sandpiper (*Calidris himantopus*)
	Buff-breasted Sandpiper (*Calidris subruficollis*)
	Short-billed Dowitcher (*Limnodromus griseus*)
	Wilson's Snipe (*Gallinago delicata*)
	American Woodcock (*Scolopax minor*)
Note: Species at risk and species of conservation concern are shown in **bold** font	

6.2.5 Other Marine-Associated Avifauna

Many passerines, raptors and other landbirds breed in Newfoundland. Although most do not regularly occur in the marine environment, some species of landbirds are associated with coastal habitats including the Bank Swallow, Savannah Sparrow and Short-eared Owl, which typically nest along the coast, as well as some raptor species such as the Peregrine Falcon that prey upon concentrations of shorebirds during migration. Further, many landbirds fly long distances over water during migration, and although they tend to remain fairly close to shore, nocturnal migrants (including most passerines) are attracted to artificial light sources at sea, particularly in foggy conditions during the late summer to fall months (July to early November). Landbirds are therefore considered to be infrequent visitors to the Project Area and larger RSA, particularly outside the fall migration period.

6.2.6 Species at Risk and Otherwise of Special Conservation Concern

Very few avian species at risk or species of conservation concern are likely to occur in the RSA. The Ivory Gull is found almost exclusively in marine environments, and although its breeding distribution (and critical habitat) is in the Arctic, it regularly occurs in small numbers in the waters off Eastern Newfoundland. Two waterfowl SAR, the Barrow's Goldeneye and Harlequin Duck, both occur in the

marine environment, particularly outside of the breeding season. Like other waterfowl species, they prefer coastal areas and so are considered unlikely to be present offshore Eastern Newfoundland. Red-necked Phalaropes, assessed by COSEWIC as a species of conservation concern, were seen in small numbers during ECSAS surveys in offshore waters from April to December. The other avian species at risk or species that are otherwise of conservation concern that occur in Newfoundland (Table 6.23) are shorebirds and landbirds, and are unlikely to be found in the RSA except on a transient basis during the fall months.

Bird species at risk or species of conservation concern in Newfoundland and Labrador that do not inhabit coastal or offshore environments, or that only migrate over the ocean in the daytime, are not assessed further in this section. These include the Red Crossbill, which is a non-migratory forest dweller (Environment Canada 2006); and three diurnally migrating landbirds, the Rusty Blackbird (Avery 2013), Chimney Swift (Steeves et al 2014) and Barn Swallow (Brown and Brown 1999).

A summary of avian species at risk that occur in the province, including information on their habitat preferences and potential to occur in the RSA, is provided in Table 6.23.

Table 6.23 Avian Species at Risk and their Likelihood of Occurrence in the Project Area and RSA

Species	Provincial Status	Federal Status		Habitat and Distribution in Newfoundland	Potential Presence
		SARA Schedule 1 Listing	COSEWIC Assessment		
Barrow's Goldeneye (Eastern pop.)	Vulnerable	Special Concern	Special Concern	• Does not breed in Newfoundland. Moults and winters in small numbers off the coast of Eastern Canada, often in groups with Common Goldeneye. Small numbers have been reported wintering at Port Blandford and Newman Sound in Terra Nova National Park, as well as Traytown Bay, St. Mary's Bay, and Spaniard's Bay (Schmelzer 2006). • Known to congregate in relatively small geographic areas in important shipping corridors (Schmelzer 2006).	Unlikely, due to their affinity for coastal habitats.
Harlequin Duck (Eastern pop.)	Vulnerable	Special Concern	Special Concern	• Breed in fast-flowing streams, and congregate in moulting sites in the late summer to fall. May breed in Bay du Nord River in southeastern Newfoundland (Bird Studies Canada 2017).	Unlikely, due to their affinity for coastal habitats.

Species	Provincial Status	Federal Status		Habitat and Distribution in Newfoundland	Potential Presence
		SARA Schedule 1 Listing	COSEWIC Assessment		
				• Found in coastal marine environments throughout fall and winter along rocky coastlines, subtidal ledges, and exposed headlands. Non-breeding individuals may be found year round at Cape St. Mary's, one of few known moulting sites in the province (Bird Studies Canada 2017; NLDEC 2017a).	
Ivory Gull	Endangered	Endangered	Endangered	• Breeds in the far north and winters offshore. • Spend almost all of their time in the marine environment, including within the RSA. • Present in small numbers in the waters off Eastern Newfoundland, usually among pack ice. • Rarely seen on the coast of the Northern Peninsula and ashore (Stenhouse 2004; NLDEC 2017a).	Potentially present. Because they are typically found among pack ice, interactions with Project activities are unlikely.
Piping Plover (*Melodus* ssp.)	Endangered	Endangered	Endangered	• During the nesting season, found on sandy beaches along the coast. • In Newfoundland, breeding population is concentrated in the southwest and western portions of the Island (NLDEC 2017a); major breeding areas include Grand Bay West to Cheeseman Provincial Park and Big Barasway, and nesting has also been observed in Codroy Valley Estuary (Bird Studies Canada 2017). However, in 2013, breeding was reported at Deadman's Bay near the Cape Freels Coastline IBA in northeastern Newfoundland.	Unlikely, due to their affinity for coastal habitats.

Species	Provincial Status	Federal Status		Habitat and Distribution in Newfoundland	Potential Presence
		SARA Schedule 1 Listing	COSEWIC Assessment		
Red Knot (*Rufa* ssp.)	Endangered	Endangered	Endangered	• Found on open sandy inlets, coastal mudflats, sand flats, salt marshes, sandy estuaries and areas with rotting kelp deposits during fall migration, from August 1st to October 30th (Garland and Thomas 2009; NLDEC 2017a). • Sightings have been reported around almost the entire coast of Newfoundland, mostly on the west coast (Baker et al 2013). • In Atlantic Canada Shorebird Survey, they are considered regular or occasional species during fall migration at Bellevue Beach, Cape Freels, and around the Codroy Valley Estuary, and they are rare visitors at other survey sites (Environment Canada 2009).	Unlikely, due to their affinity for coastal habitats.
Buff-breasted Sandpiper	none	none	Special Concern	• Arctic breeders; during fall migration, considered to be a rare migrant in the province (COSEWIC 2012). • Occasionally observed in Atlantic Canada Shorebird Surveys at St. Shott's Sod Farm near the southern shore of the Avalon Peninsula and at Cape Bonavista. Reported in small numbers at other survey sites (Environment Canada 2009).	Unlikely, due to their affinity for coastal habitats.
Red-necked Phalarope	none	none	Special Concern	• Outside the breeding season, found in coastal marine environment (Rubega et al 2000). • Surface feeders, often congregating in areas such as upwellings with higher prey densities. • In the Atlantic Canada Shorebird Survey, considered	Potentially present. Seen in small numbers during ECSAS surveys within the RSA, although scarce in the winter and

Species	Provincial Status	Federal Status		Habitat and Distribution in Newfoundland	Potential Presence
		SARA Schedule 1 Listing	COSEWIC Assessment		
				rare visitors at Cape Spear and at Bonavista/ Cape Bonavista (Environment Canada 2009).	spring (CWS 2017).
Peregrine Falcon	Vulnerable	Special Concern	Special Concern	• Migrates along the coast of Newfoundland during the fall (particularly the west coast), preying on concentrations of migrating shorebirds. • Peregrine Falcon sightings have been reported in the fall near Port-aux-Basques, St. Pierre et Miquelon, and on the Bonavista Peninsula, and year-round (most frequently during the fall) on the Avalon Peninsula (White et al 2002).	Unlikely to occur regularly. May be an occasional vagrant during fall migration.
Common Nighthawk	Threatened	Threatened	Threatened	• Nests in open areas (e.g. coastal sand dunes and beaches, logged or slashburned areas of forest sites, woodland clearings, grassland habitat, farm fields, open forests, rock outcrops, and flat gravel rooftops). • Does not breed in insular Newfoundland (Brigham et al 2011), but migrates through province.	Unlikely to occur regularly. May be an occasional vagrant during fall migration.
Bank Swallow	none	none	Threatened	• Bank Swallows are colonial, often nesting in sandy banks created through coastal erosion; therefore, potentially in close proximity to the marine environment during the breeding season. • Diurnal migrants (Garrison 1999). • Within the province, breeds primarily in southwestern Newfoundland (Warkentin and Newton 2009); however, sightings have also been reported in Eastern	Unlikely, due to their affinity for coastal habitats. As diurnal migrants, they are less susceptible to disorientation from offshore artificial light sources.

Species	Provincial Status	Federal Status		Habitat and Distribution in Newfoundland	Potential Presence
		SARA Schedule 1 Listing	COSEWIC Assessment		
				Newfoundland (Garrison 1999).	
Gray-cheeked Thrush (*minimus* ssp.)	Threatened	none	Candidate Species (low priority)	• Nests in dense coniferous forest habitat throughout insular Newfoundland and overwinters in South America, migrating nocturnally (Lowther et al 2001). • Most common on the Northern Peninsula and along the northeast coast, as well as the northern Avalon Peninsula (Endangered Species and Biodiversity Section 2010). • Has also been reported in Placentia Bay (Endangered Species and Biodiversity Section 2010) and breeds in Terra Nova National Park (Bird Studies Canada 2017).	Unlikely to occur regularly. May be an occasional vagrant during fall migration.
Olive-sided Flycatcher	Threatened	Threatened	Threatened	• Found in boreal forest habitat, particularly open areas such as wetlands with tall trees and snags. • Migrates to south and central America to overwinter (Altman and Sallabanks 2012). • Breeds throughout insular Newfoundland and Southern Labrador (COSEWIC 2007), and in Eastern Newfoundland it has been reported at several locations on the Avalon Peninsula as well as at Terra Nova National Park (Altman and Sallabanks 2012).	Unlikely to occur regularly. May be an occasional vagrant during fall migration.
Bobolink	Vulnerable	none	Threatened	• Nests in agricultural and natural grasslands, and migrates to South America in the fall (Renfrew et al 2015).	Unlikely to occur regularly. May be an occasional

Species	Provincial Status	Federal Status		Habitat and Distribution in Newfoundland	Potential Presence
		SARA Schedule 1 Listing	COSEWIC Assessment		
				• Breeding has been reported at Codroy Valley (Bird Studies Canada 2017), and there have been sightings on the Avalon Peninsula and Terra Nova National Park (Renfrew et al 2015).	vagrant during fall migration.
Short-eared Owl	Vulnerable	Special Concern	Special Concern	• Typically nests in coastal barrens and grasslands (Wiggins et al 2006), and suitable habitat occurs in much of coastal Newfoundland. • Sightings have been reported throughout the eastern portion of insular Newfoundland from Wadham Islands to the Avalon and Burin Peninsulas, and near Port-aux-Basques and Codroy Valley in southwestern Newfoundland, mostly in the summer months (Schmelzer 2005; Wiggins et al 2006).	Unlikely, due to their affinity for coastal habitats.

6.2.7 Important Times and Areas for Marine and Migratory Birds

This section summarizes the temporal and geographical presence of marine and migratory birds. Although seabirds utilize the Project Area and RSA throughout the year, the abundance, distribution and species composition vary considerably. Some taxa (such as large gulls and kittiwakes, many alcid species, fulmars and shearwaters) are abundant year-round, while other groups are absent or scarce during part of the year. Areas of importance for marine and migratory birds include designated key habitats and breeding colonies; these are found in coastal areas and inland, although birds that use these areas may forage in the offshore environment.

6.2.7.1 Temporal Considerations

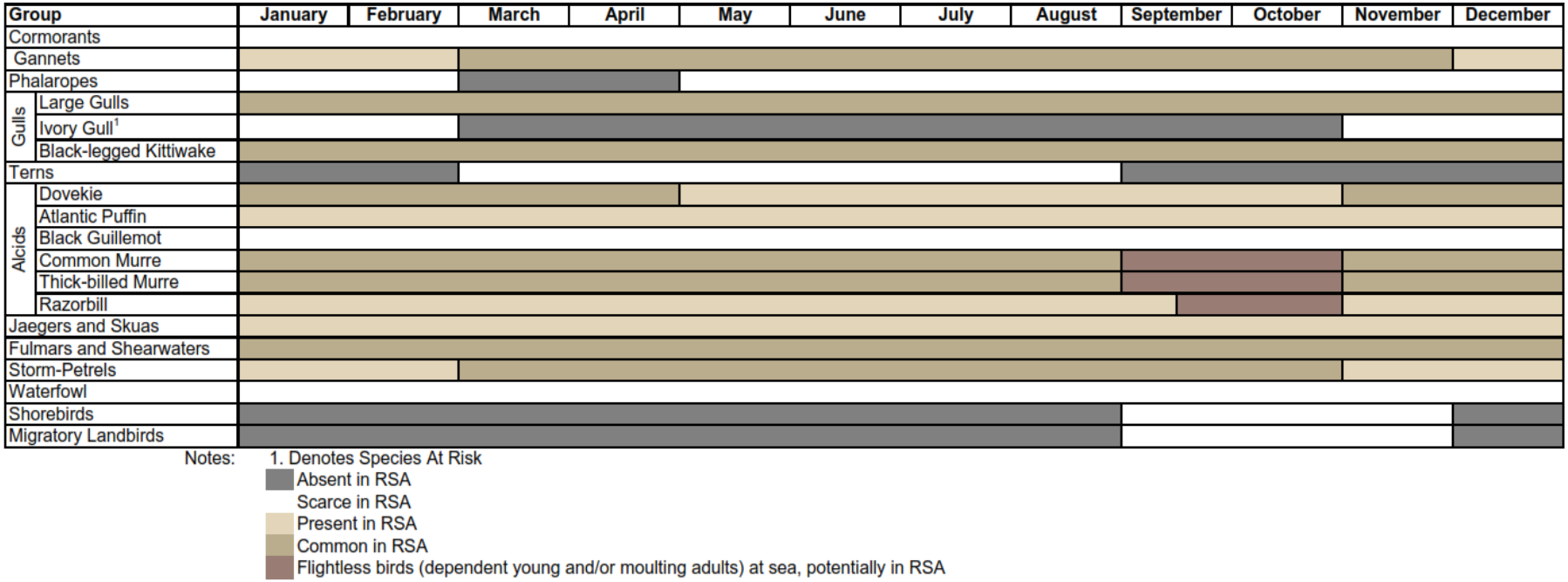
Figure 6.43 summarizes the overall seasonal presence of marine-associated bird species in the Project Area and larger RSA. In the summer months, the greatest abundance of seabird species breeding in Newfoundland is concentrated around nesting colonies (Fifield et al 2009). However, seabirds are relatively long-lived and in many species, individuals do not breed until four or five years of age. Therefore, even during the breeding season large numbers of non-breeding birds may be found far offshore. Some Southern Hemisphere-breeding species spend the summer months (austral non-

breeding season) in the northwest Atlantic, including most of the world's Great Shearwaters (Brown 1986).

The fall months are an important time for Leach's Storm-petrels and migrating landbirds (particularly passerines, which tend to be nocturnal migrants), as these species are vulnerable to disorientation from artificial light sources. The Leach's Storm-petrel is the species most frequently found stranded on platforms and vessels in and near the RSA (Ellis et al 2013; Environment Canada 2015), with the vast majority of strandings occurring in September and October, following the departure of fledglings from nearby breeding colonies (Huntington et al 1996). At all times of year, but especially outside the breeding season, alcids are considered particularly vulnerable to the potential effects of oil pollution because they spend a large proportion of their time on the water relative to more aerial species (Fifield et al 2009) and congregate over relatively small, productive areas such as around the Grand Banks (Gaston et al 2011; Hedd et al 2011; Montevecchi et al 2012; Fort et al 2013; McFarlane Tranquilla et al 2013). Alcid vulnerability in the region is at its highest during the post-breeding season moulting period (Gaston and Hipfner 2000; Ainley et al 2002; Montevecchi and Stenhouse 2002; Lavers et al 2009).

Certain groups are absent or scarce in the winter months, such as gannets, terns, cormorants and phalaropes. In the marine environment off Eastern Newfoundland, Ivory Gulls and waterfowl (including Harlequin Duck and Barrow's Goldeneye) are most abundant outside of the breeding season, and so the greatest potential for presence of these species at risk is in the winter months. During the winter months, tens of millions of Dovekies travel several thousand kilometers from their breeding grounds to their core winter distribution within the highly productive waters off Eastern Newfoundland (Fort et al 2012, 2013). In the winter months, the waters off Eastern Canada support a large proportion of the Icelandic population of Great Skuas (Magnusdottir et al 2012). A recent tracking study of Black-legged Kittiwakes has shown that the northwest Atlantic, particularly the shelf edge off Newfoundland, is a particularly important wintering area for kittiwakes, with most of the Atlantic population overwintering in this region (Frederiksen et al 2012). Most of Eastern Canada's population of Common Murres and approximately a third of the region's Thick-billed Murres overwinter in the waters off Eastern Newfoundland (McFarlane Tranquilla et al 2013).

Figure 6.43 Summary of Seasonal Presence of Marine-Associated Birds



6.2.7.2 Key Areas

Breeding colonies for marine and migratory birds are found in coastal areas; at more than 400 kilometers offshore, the Project Area is outside of the reported foraging range of most species breeding at the major seabird colonies in coastal Newfoundland. Northern Gannets and Leach's Storm-petrels will, however, travel hundreds of kilometres from their colonies over multi-day foraging trips (Garthe et al 2007; Pollet et al 2014) and so nesting individuals may forage in the Project Area. Breeding colonies for marine and migratory birds are shown in Figure 6.44.

Areas of particular importance to the survival of bird species may be given the designation of IBA. The IBA program is coordinated by BirdLife International, and administered in Canada by the Canadian Nature Federation and Bird Studies Canada. The criteria used to identify important habitat are internationally standardized, and are based on the presence of species at risk, species with restricted range, habitats holding representative species assemblages, or a congregation of a significant proportion of a species' population during one or more season. These criteria are used to identify sites of national and international importance. There are a total of 21 IBA sites in Eastern Newfoundland (Bird Studies Canada 2017), along the coastline and inland, outside the Project Area. These are summarized in Table 6.24. Further information on these IBAs is provided in Section 6.4.4.

Table 6.24 IBAs in Eastern Newfoundland and Labrador

IBA Name	Area (km^2)	Location	Importance
St. Peter Bay (LB023)	170.59	30 km south of Mary's Harbour on the southeast coast of Labrador. Includes the bay and several small islands within.	• Major moulting area for Common Eiders • Thought to be an important congregating area for Harlequin Ducks in the non-breeding season.
Point Amour (LB022)	107.23	On the Labrador side of the narrowest point of the Strait of Belle Isle.	• Important migratory corridor for waterbirds in the spring and fall, including large numbers of Dovekie, Common Eider, Black Guillemot and large alcids (Razorbills and possibly Common and/or Thick-billed Murres).
Fischot Islands (NF008)	56.78	A group of small islands, isolated rocks, and shoals at the southeast head of Hare Bay, on the northeast side of the Northern Peninsula.	• Globally significant wintering congregation of Common Eiders.
Northern Groais Island (NF009)	173.42	Off the eastern side of the Northern Peninsula.	• Breeding colony of Black-legged Kittiwakes. • Wintering congregation of Common Eiders.
Bell Island South Coast (NF010)	282.47	Off the eastern side of the Northern Peninsula, just south of Northern Groais Island.	• Largest colony of nesting Common Eiders on insular Newfoundland (over 1,000 pairs). • During winter, thousands of Common Eiders congregate. • Reports of Harlequin Ducks in the non-breeding season. • The Shepherd Island and Île aux Canes Migratory Bird Sanctuaries are part of this IBA.

IBA Name	Area (km^2)	Location	Importance
Funk Island (NF004)	135.18	Island off northeastern Newfoundland, approximately 60 km from shore.	• Major concentration of nesting seabirds. • Globally significant Common Murre population. • Large numbers of Northern Gannets. • Provincially protected Seabird Ecological Reserve; as such, access to the island is restricted to scientific researchers.
Wadham Islands and adjacent Marine Area (NF013)	159.23	Near Fogo Island, approximately 40 km offshore; includes 7 main islands and several smaller rocks and shoals.	• Globally significant number of wintering Common Eider (approximately 25,000 counted in a 1995 survey). • Large numbers of nesting Atlantic Puffin, Leach's Storm-Petrel and Razorbill.
Cape Freels Coastline and Cabot Island (NF025)	334.48	At the head of Bonavista Bay; includes several small islands and shoals.	• Up to 25,000 wintering Common Eiders have been reported between the Cape Freels coastline and Wadham Islands. • Large numbers of nesting Common Murres, as well as some pairs of Razorbills. • Historic records of breeding Atlantic Puffins, although none were recorded in recent EC-CWS surveys.
Terra Nova National Park (NF017)	655.56	On the inner reaches of Bonavista Bay. Much of the area is forested, but there are numerous lakes and wetlands, as well as a significant coastal component.	• Numerous forest species nest here, including two subspecies with restricted ranges: the federally-listed Red Crossbill (*percna* ssp.) and Ovenbird (*furvoir* ssp.). • Shorebirds, gulls and waterfowl can be seen on the flats at the outlet of Big Brook, as well as Newman Sound. • At least six tern colonies (Common and Arctic Tern), totalling between 1000 and 1500 pairs. • Also a federally designated Migratory Bird Sanctuary.
Grates Point (NF019)	66.55	The northern tip of the Bay de Verde Peninsula, which separates Trinity Bay from Conception Bay.	• Large number of wintering Common Eiders (up to 12,000 individuals, but typically around 2,800). • Other wintering species include Black-legged Kittiwake, Thick-billed Murre and Dovekie. • Atlantic Puffin and Northern Gannet are present in the summer months.
Baccalieu Island (NF003)	45.22	5.5 km from the northern tip of the Avalon Peninsula.	• Greatest seabird abundance and diversity in Eastern North America. • World's largest colony of Leach's Storm-petrels, including 70 percent of the North American population. • Significant numbers of breeding Atlantic Puffin, Black-legged Kittiwake and Northern Gannet.

IBA Name	Area (km^2)	Location	Importance
			• Smaller numbers of nesting Common Murre, Thick-billed Murre, Razorbill, Black Guillemot, Northern Fulmar, Herring Gull and Great Black-backed Gull. • Like Funk Island, a provincially designated Seabird Ecological Reserve.
Cape St. Francis (NF021)	70.21	At the northern tip of the Avalon Peninsula.	• Winter congregating area for Common Eiders; up to 5000 individuals recorded. • Purple Sandpipers regularly observed along the rocky shoreline in the winter.
Quidi Vidi Lake (NF022)	7.0	Within St. John's city limits, and fed by the Virginia River and Rennies River.	• Important daytime resting site for gulls from late fall to early spring, including significant numbers of Herring, Great Black-backed, Iceland, Glaucous and Common Black-headed Gulls. • Locally rare Ring-billed Gull, Mew Gull and Lesser Black-backed Gull occasionally reported. • Waterfowl including American Black Ducks, Mallards and Northern Pintails are common in the winter, subsisting on food handouts from people.
Witless Bay Islands (NF002)	62.08	Composed of four small islands off the east coast of the Avalon Peninsula.	• Provincially designated Seabird Ecological Reserve. • Globally significant numbers of breeding seabirds, including more than half of the eastern North American population of Atlantic Puffins and almost 10% of the global Leach's Storm-petrel population. • Large numbers of nesting Common Murres, Black-legged Kittiwakes and Herring Gulls. • Great Black-back Gulls, Northern Fulmars, Thick-billed Murres, Razorbills and Black Guillemots nest in smaller numbers. • During the fall migration, surrounding marine area is important to sea ducks including White-winged Scoter, Surf Scoter, Long-tailed Duck and Common Eider.
Mistaken Point (NF024)	102.77	Near the southeastern corner of the Avalon Peninsula.	• Important wintering area for up to 12,000 Common Eiders. • Continentally significant numbers of wintering Purple Sandpiper (> 1% of North American population). • Small numbers of overwintering Ruddy Turnstone, far north of its usual wintering range. • Nesting Black-legged Kittiwake, Common Murre and Razorbill.

IBA Name	Area (km^2)	Location	Importance
			• Provincially designated Ecological Reserve because of its rich fossil deposits.
Cape St. Mary's (NF001)	329.39	Located at the entrance to Placentia Bay on the southwestern Avalon Peninsula.	• Significant numbers of nesting Northern Gannet (> 2% of global population). • Large numbers of Common Murre and Black-legged Kittiwake, and smaller numbers of nesting Thick-billed Murre, Razorbill, Great Cormorant and Double-crested Cormorant. • Herring Gull, Great Black-backed Gull and Black Guillemot historically reported nesting. • In the winter, large numbers of migrating sea ducks including scoters, Common Eider, Long-tailed Duck and the endangered Harlequin Duck. • Small numbers of Harlequin Duck during summer, moulting season in some years. • Designated as a provincial Seabird Ecological Reserve.
Placentia Bay (NF028)	1398.05	Includes the eastern half of Placentia Bay in southeastern Newfoundland (between the Avalon and Burin Peninsulas), and extends out 25 km from shore	• Exceptional feeding area for seabirds during the summer capelin spawning season. • More than 100,000 shearwaters recorded in a single survey (mostly Greater and Sooty Shearwater, some Manx Shearwater). • Large numbers of other species breeding at Cape St. Mary's feed here, including Northern Gannet, Black-legged Kittiwake, Atlantic Puffin, Thick-billed Murre and Common Murre. • Large numbers of feeding Pomarine and Parasitic Jaegers. • More than 1,000 wintering Common Eiders.
Cape Pine and St. Shotts Barren (NF015)	57.4	Southern tip of the Avalon Peninsula.	• Large, possibly globally significant numbers of American Golden-Plover during their fall migration (August to mid-October). • Dozens of Whimbrel during fall migration.
Corbin Island (NF030)	5.25	Southeast corner of the Burin Peninsula.	• An estimated 100,000 pairs of nesting Leach's Storm-petrels (2% of western Atlantic population). • Historic records of Herring Gull, Great Black-backed Gull, Black Guillemot and Black-legged Kittiwake colonies.
Middle Lawn Island (NF031)	4.17	A small, rugged island off the southern tip of the Burin Peninsula.	• One of the few known colonies of Manx Shearwaters in North America, as well as the largest with up to 100 pairs reported; another 300 non-breeding individuals are estimated to be present.

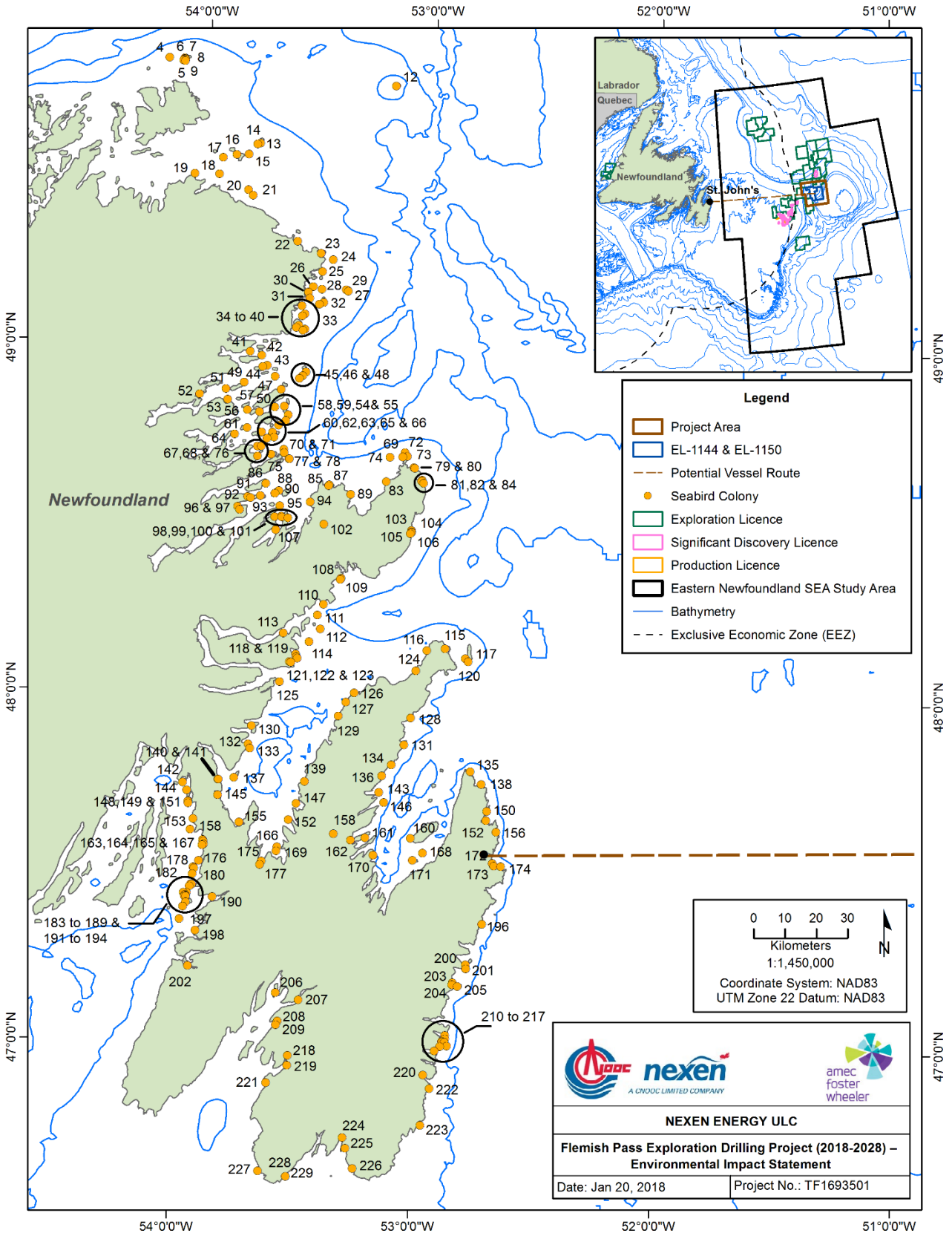
IBA Name	Area (km^2)	Location	Importance
			• Globally significant numbers of Leach's Storm-petrels breed on the island. • Black Guillemot, Herring Gull and Great Black-backed Gull have been reported breeding. • Part of the Lawn Islands Archipelago, a provisional Seabird Ecological Reserve.
Green Island (NF032)	5.61	Midway between the Burin Peninsula and St. Pierre and Miquelon.	• Globally significant colony of Leach's Storm-petrels. • Common Tern, Arctic Tern and small numbers of Herring Gull have been reported breeding. • Spotted Sandpipers observed in the summer. • Manx Shearwater and Black Guillemot may breed on the island.
Source: Important Bird Areas of Canada (Bird Studies Canada 2017); Atlantic Canada Colonial Waterbird database (CWS 2017)			

Environment and Climate Change Canada has also designated several Migratory Bird Sanctuaries (MBSs) in Canada, which are protected by the federal Migratory Bird Sanctuary Regulations which prescribe rules and prohibitions regarding the taking, injuring, destruction or molestation of migratory birds or their nests or eggs in the sanctuaries. Hunting of migratory species is not permitted in any MBS.

There are three MBSs in the Eastern Newfoundland region: Terra Nova MBS, which is also an IBA, and the Shepherd Island and Île aux Canes Migratory Bird Sanctuaries which are part of the Bell Island South Coast IBA (Table 6.24). Provincially, there are also several protected Wilderness and Ecological Reserves, including seven designated Seabird Ecological Reserves, five of which are in Eastern Newfoundland (NLDEC 2017b). Many of these sites, including Witless Bay, Lawn Bay (which includes Middle Lawn Island), Baccalieu Island, Cape St. Mary's and Funk Island, are also IBAs and have been discussed in Table 6.24. The provincial Seabird Ecological Reserve Regulations, 2015 prohibit or limit industrial development as well as certain activities that can cause disturbance to breeding seabirds, including limitations on hiking, boat traffic and low-flying aircraft near the colonies during the breeding season, and prohibition of ATVs at all times. As well, Mistaken Point is a designated Ecological Reserve because of its rich assemblage of fossils, and as such is afforded similar protection from development and off-road vehicles. In addition to designated IBAs and MBSs, breeding sites for colonial species also constitute particularly important areas and habitats for marine birds. Figure 6.44 shows the locations of known seabird colonies off Eastern Newfoundland.

A number of EBSAs have also been identified within the Placentia Bay Grand Banks Large Ocean Management Area (PBGB LOMA) (Templeman 2007). Among the criteria for selection and ranking of these areas was their importance to seabirds in terms of biodiversity, density and importance to reproduction and survival. Three EBSAs overlap the RSA (Section 6.4.1), one of which, the Southeast Shoal and Tail of the Banks, was selected in part because large, diverse aggregations of seabirds are attracted to the offshore spawning areas for major forage species including capelin and sandlance (Templeman 2007).

Figure 6.44 Seabird Colony Locations in Eastern Newfoundland



6.3 Marine Mammals and Sea Turtles

The waters off Eastern Newfoundland support a diverse assemblage of marine fauna throughout the year. Marine mammals and turtles are considered ecologically, economically, culturally, and recreationally important to various stakeholder groups, including government agencies, Indigenous groups and other interested parties. Over 20 marine mammals and five sea turtle species have been reported in and near the Project Area and larger RSA, including several that are considered to be at risk or otherwise of special conservation concern.

This section provides an overview of marine mammal and sea turtles, including species at risk, that have potential to occur in the area. Detailed life history and habitat information for these species, as well as information about key areas and times of year, can be found in the Eastern Newfoundland SEA (Amec 2014, see Section 4.2.3). Any new data, as well as key information and analysis specific to the Project Area and RSA for this assessment, is summarized in the following subsections.

Sightings data for marine mammals and sea turtles within the RSA were obtained from the Ocean Biogeographic Information System (OBIS), which include the following sources:

- Bureau of Land Management (BLM) Cetacean and Turtle Assessment Program (CETAP);
- Canadian Wildlife Service – Environment and Climate Change Canada (CWS-ECCC) Eastern Canada Seabirds at Sea (ECSAS) (opportunistic sightings);
- PIROP Northwest Atlantic 1965–1992 (opportunistic sightings);
- DFO Maritimes Region Cetacean Sightings;
- National Oceanic and Atmospheric Administration records;
- NOAA Northeast and Southeast Fisheries Science Center surveys;
- Visual sightings from Song of the Whale 1993-2013;
- Lamont-Doherty/LGL/NSF cruises;
- UK Royal Navy Marine Mammal Observations; and
- HMAP Dataset 04: World Whaling

In addition to the compiled OBIS data, cetacean observations from the DFO Marine Mammals Sightings Database, which includes sightings from the late 1940s to 2013, were obtained from Dr. Jack Lawson of DFO. Although useful and informative at a regional scale, there are several caveats associated with these datasets which must be noted. Because the data collection is not standardized across surveys, and the sightings effort is not quantified, the data cannot be used to estimate species abundance or density. A lack of sightings may reflect a deficiency of survey effort in a given area and cannot be interpreted as absence of a particular species; similarly, a cluster of sightings may reflect high survey effort rather than a large number of individuals in a particular area. As well, observers may have varying degrees of experience and expertise in marine mammal identification, and the data have not been completely error-checked and the quality of some of the information is therefore unknown. Most sightings are collected on an opportunistic basis. Most data have been gathered from platforms of opportunity that were vessel-based, and the possible negative or positive reactions by cetaceans to such vessels have not yet been factored into the data. Numbers sighted have not been verified, especially in light of the significant differences in detectability between species. For completeness, these data represent an amalgamation of sightings from a variety of years and seasons; the effort is not necessarily consistent among seasons, years, and areas, and there are gaps between years.

Finally, many sightings could not be identified to the species level due to factors such as distance or poor visibility, and these have been assigned to the smallest taxonomic group possible, using classifications such as “unidentified dolphin species” or, for example, “unidentified *Balaenoptera* sp.”.

6.3.1 Mysticetes

Six species of the cetacean suborder Mysticetes (the baleen whales) regularly occur in the waters off Eastern Newfoundland (Table 6.25). The bowhead whale, an Arctic species, has been observed off the coast of Newfoundland. Sightings of Mysticetes species obtained from OBIS and the DFO Marine Mammals Sightings database are shown in Figure 6.45.

Table 6.25 Overview of Mysticetes that are Known or Likely to Occur in the Project Area and RSA

Family	Species
Balaenidae – Right Whales	North Atlantic Right Whale (*Eubalaena glacialis*)
Balaenopteridae – Rorquals	Common Minke Whale (*Balaenoptera acutorostrata*)
	Sei Whale (*Balaenoptera borealis*)
	Blue Whale (*Balaenoptera musculus*)
	Fin Whale (*Balaenoptera physalus*)
	Humpback Whale (*Megaptera novaengliae*)

These large whales are characterized by having plates of baleen, which filter food items from seawater, in place of teeth. Baleen whales are typically solitary or clustered in small groups, and within groups, baleen whales are social, and acoustic communication (vocalizations and other underwater sounds) is critical to maintaining complex social structures. Baleen whales may be found in coastal as well as offshore areas, typically foraging at depths of 100 m to 150 m. Blue whales and common minke whales may be found in the area throughout the year, while the other four species are absent in the winter months.

6.3.2 Odontocetes

The suborder Odontoceti includes toothed whales, dolphins and porpoises. In the waters off Eastern Newfoundland, 14 species of odontocetes have been regularly observed (Table 6.26). An additional species has been reported in the area, the Atlantic spotted dolphin (OBIS 2017), a species that is generally found in tropical and subtropical waters and is therefore considered very unlikely to occur in the RSA. Sightings of odontocete species obtained from OBIS and the DFO Marine Mammals Sightings database are shown in Figures 6.46 (dolphins and porpoises) and 6.47 (other odontocetes).

Table 6.26 Overview of Odontocetes that are Known or Likely to Occur in the Project Area and RSA

Family	Species
Delphinidae – Dolphins	Short-beaked Common Dolphin (*Delphinus delphis*)
	Long-finned Pilot Whale (*Globicephala melas*)
	Risso’s Dolphin (*Grampus griseus*)
	Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)
	White-beaked Dolphin (*Lagenorhynchus albirostris*)
	Killer Whale (*Orcinus orca*)
	Striped Dolphin (*Stenella coeruleoalba*)

Family	Species
	Common Bottlenose Dolphin (*Tursiops truncatus*)
Phocoenidae – Porpoises	Harbour Porpoise (*Phocoena phocoena*)
Monodontidae – Belugas and Narwhals	Beluga Whale (*Delphinaptera leucas*)
Ziphiidae – Beaked Whales	Cuvier's Beaked Whale (*Ziphius cavirostris*)
	Sowerby's Beaked Whale (*Mesoplodon bidens*)
	Northern Bottlenose Whale (*Hyperoodon ampullatus*)
Physeteridae – Sperm Whales	Sperm Whale (*Physester macrocephalus*)

Like baleen whales, toothed whales rely heavily on acoustic means of communication. Their auditory range is much greater than that of baleen whales, ranging from 200 Hz to as high as 200 kHz (National Research Council 2003). In addition to using sound for communication, many species of toothed whales use echolocation to navigate and to locate prey (Richardson et al 1995). Toothed whales vary in habitat preferences, with belugas and harbour porpoises favouring coastal/estuarine habitats. Some dolphins may be found in both coastal areas and open ocean, and other dolphins as well as beaked whales and sperm whales are seldom observed close to shore. Typical foraging depths range from 20 m for belugas to 1,000 m for Sowerby's beaked whale and Risso's dolphin (Perrin et al 2002). Most species are thought to be present in offshore Northwest Atlantic waters year-round, but belugas are a rare winter visitor to the area, and common bottlenose dolphin and Risso's dolphin have only been observed in the summer months (Amec 2014).

6.3.3 Pinnipeds

Four seal species are known to occur regularly in the RSA (Table 6.27). Two additional seal species, the bearded seal and ringed seal, are typically Arctic dwellers but are known to occasionally occur in the area in the winter months. A single extralimital sighting of walrus has also been reported off Eastern Canada (OBIS 2017). Sightings of pinniped species obtained from OBIS are shown in Figure 6.48.

Table 6.27 Overview of Pinnipeds that are Known or Likely to Occur in the Project Area and RSA

Family	Species
Phocidae – Earless Seals	Harp Seal (*Pagophilus groenlandicus*)
	Harbour Seal (*Phoca vitulina*)
	Hooded Seal (*Cystophora cristata*)
	Grey Seal (*Halichoerus grypus*)

Some pinniped species may be found in coastal environments (harbour seal and occasionally grey seal), but most prefer open ocean habitats. Typical foraging depths range from less than four meters for harbour seals (Perrin et al 2002), up to as deep as 600 m for hooded seals (Kovacs 2008). Harp and hooded seals are most common in the RSA in the winter months (December to April), while harbour and grey seals may be present year-round. The populations of all four seal species regularly found in the area are considered secure or even increasing (Hammill et al 2012).

6.3.4 Sea Turtles

Five species of sea turtles have been reported in the waters of the Northwest Atlantic, as described in Table 6.28 and shown in Figure 6.49. Of these, only the leatherback turtle and the loggerhead sea turtle are regularly found in the RSA. Green sea turtle, hawksbill sea turtle, and Kemp's ridley sea turtle

frequent tropical and subtropical waters, but have occasionally been found in the waters off Eastern Canada in the summer months. Sightings of sea turtle species obtained from OBIS are shown in Figure 6.49.

Table 6.28 Overview of Sea Turtles that are Known or Likely to Occur in the Project Area and RSA

Family	Species
Dermochelyidae – Leatherback Turtle	Leatherback (*Dermochelys coriacea*)
Cheloniidae – Sea Turtles	Loggerhead Sea Turtle (*Caretta caretta*)

Leatherback and loggerhead sea turtles may be found in the area from April to December, but are absent in the winter months. They are rarely seen in coastal areas, preferring offshore habitats (COSEWIC 2010, 2012). Sea turtles spend much time on the ocean surface, and foraging depths are typically less than 100 m (Wyneken et al 2013). All sea turtle species found in Eastern Canada are considered to be of conservation concern (Section 6.3.5).

Figure 6.45 Baleen Whale Sightings off Eastern Newfoundland

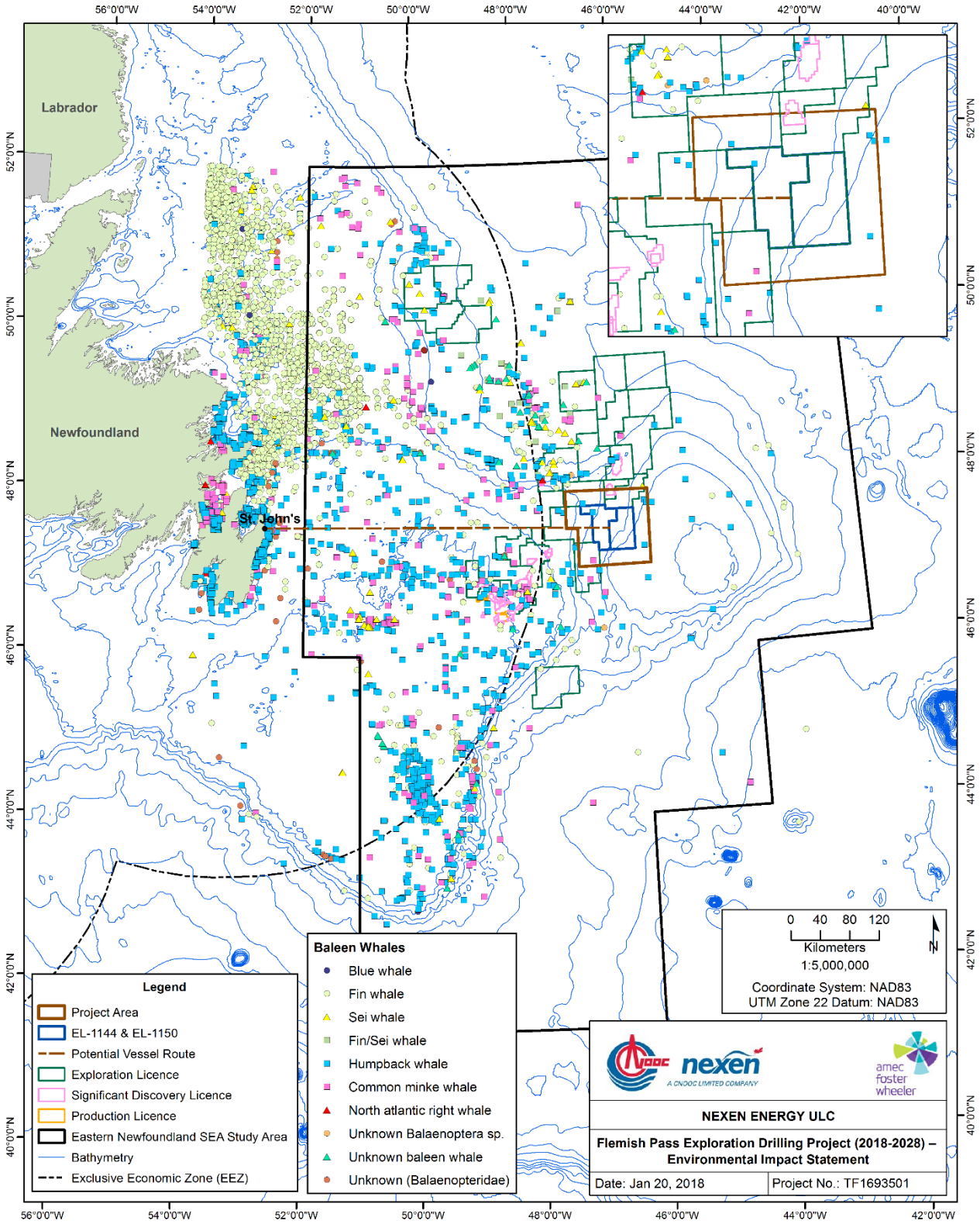


Figure 6.46 Dolphin and Porpoise Sightings off Eastern Newfoundland

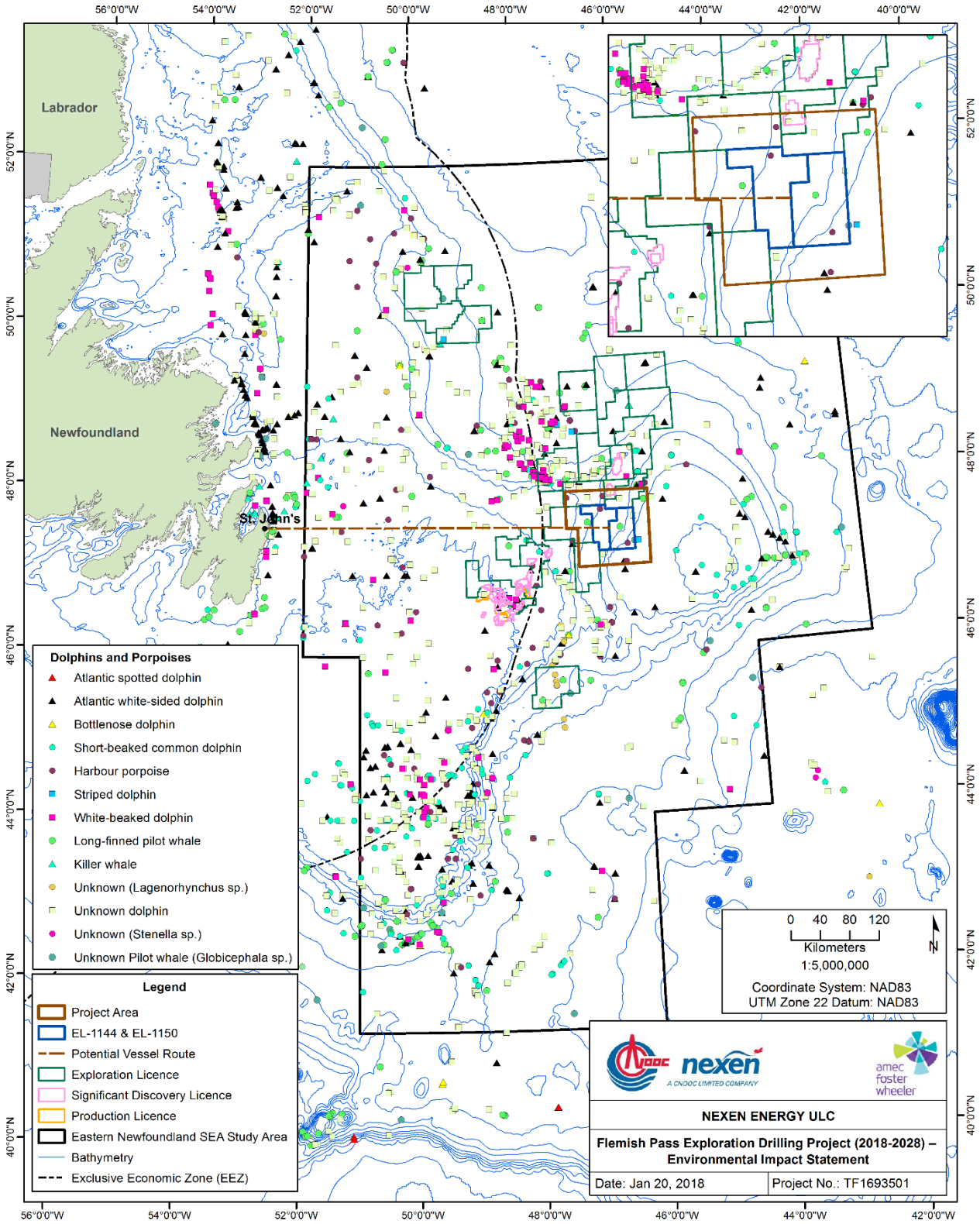


Figure 6.47 Other Toothed Whale Sightings off Eastern Newfoundland

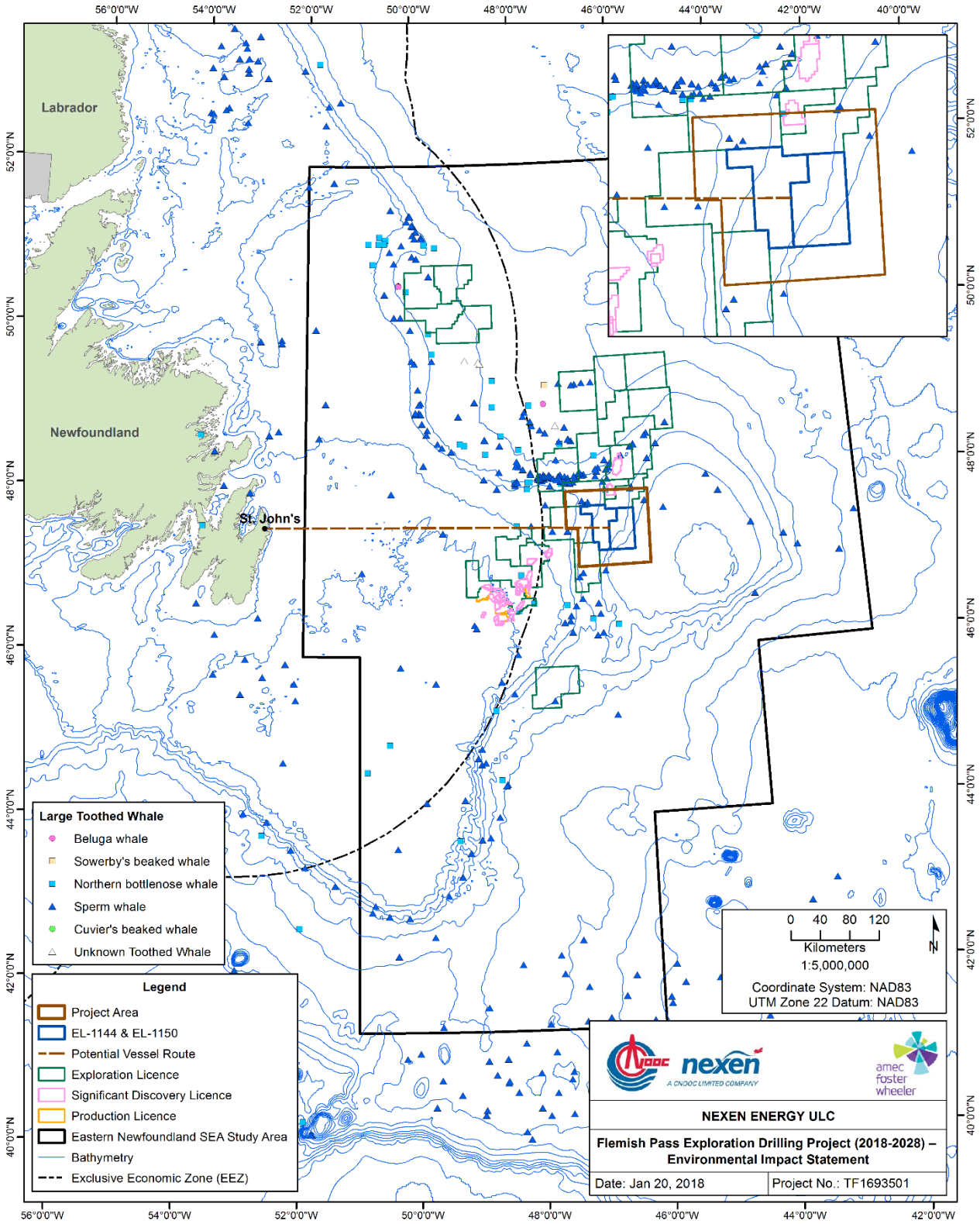


Figure 6.48 Pinniped Sightings off Eastern Newfoundland

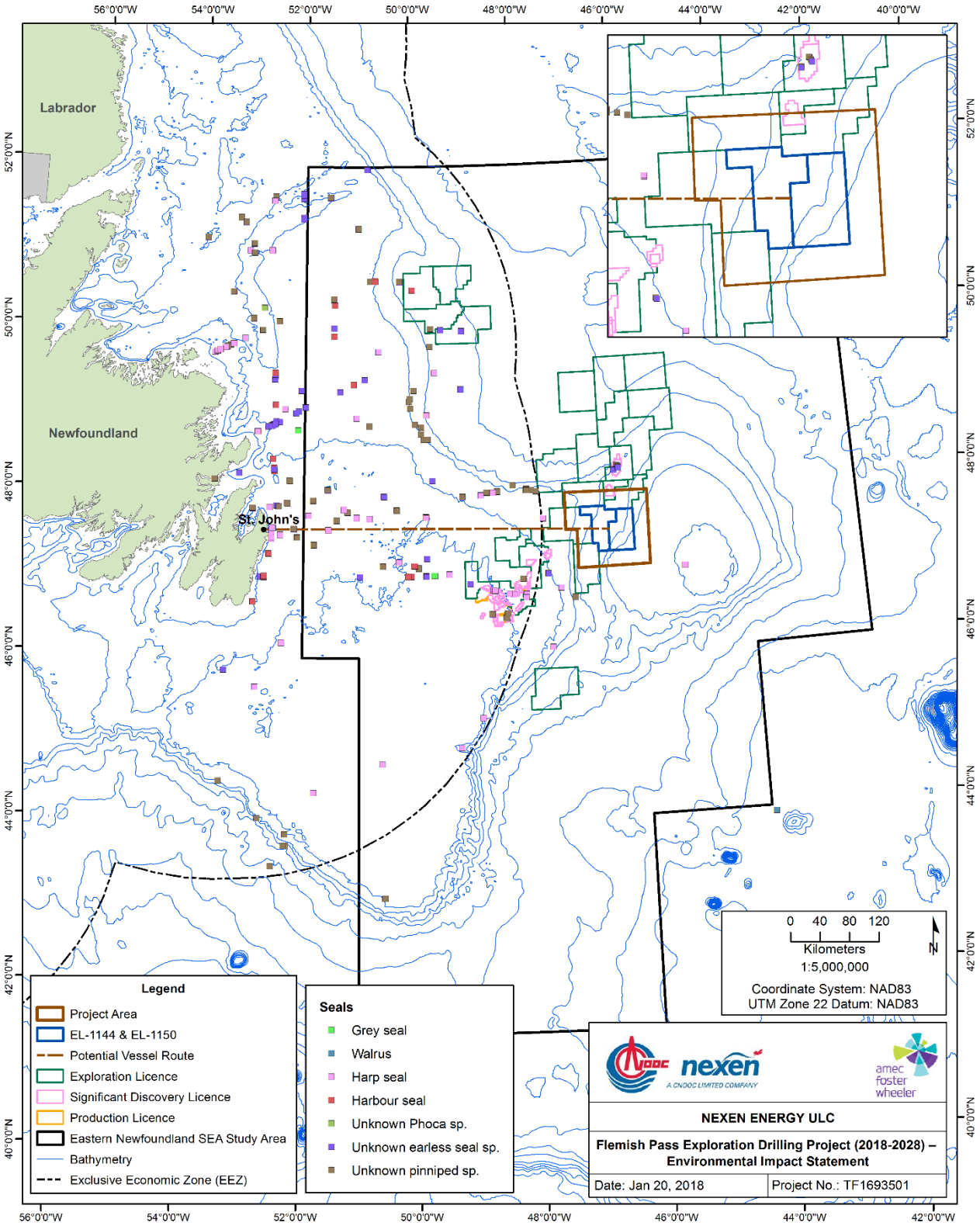
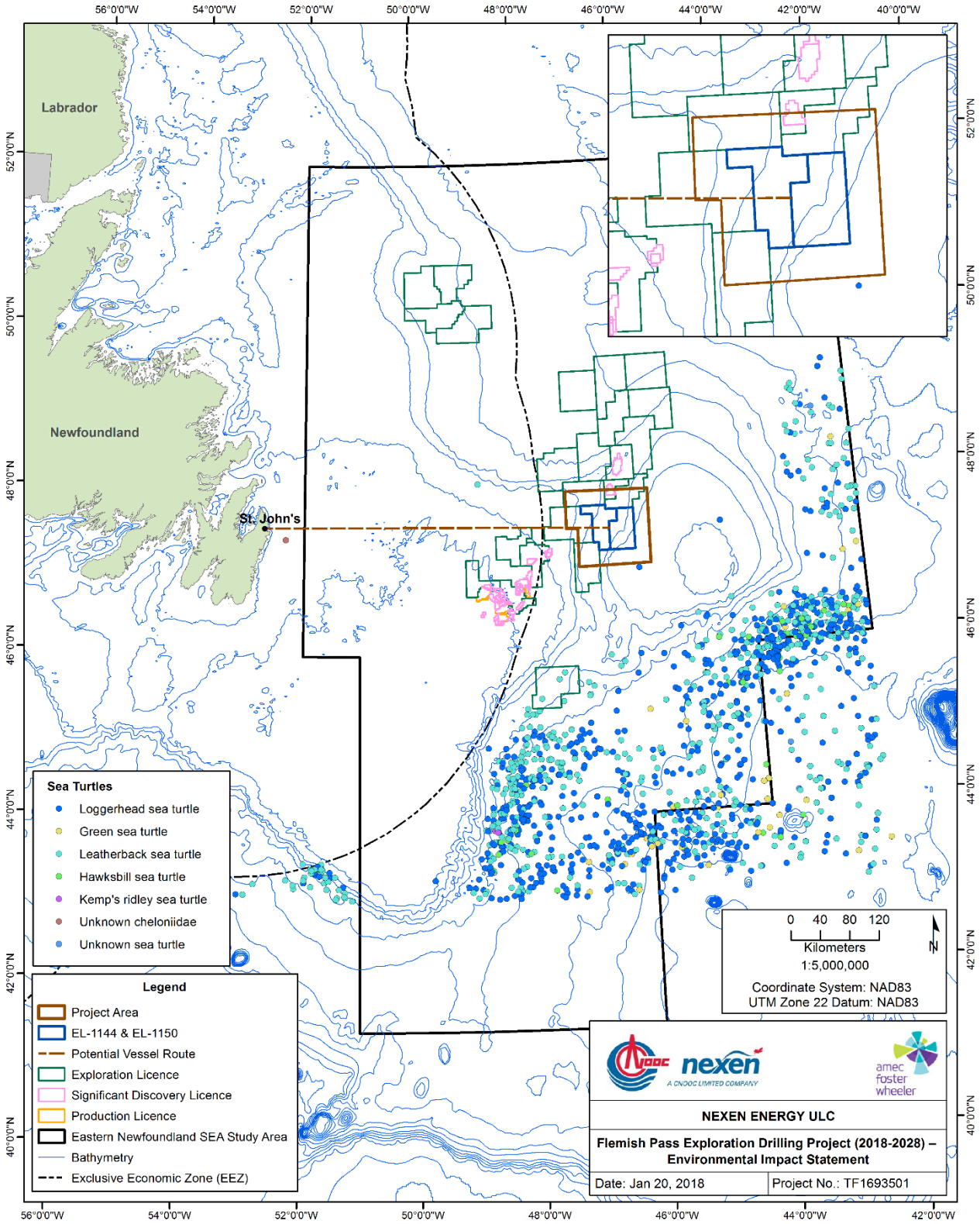


Figure 6.49 Sea Turtle Sightings off Eastern Newfoundland



6.3.5 Species at Risk and Otherwise of Special Conservation Concern

A number of marine mammal and sea turtle species at risk protected under the *SARA* occur in the waters offshore Eastern Newfoundland, as well as other species that have been identified as being of conservation concern by COSEWIC (Table 6.29). The provincial *NL ESA* does not list any marine mammals or sea turtles. While not assessed by COSEWIC, the Kemp's ridley, green and hawksbill sea turtle are all considered to be of conservation concern by the IUCN (IUCN 2017). All three of these sea turtle species are unlikely to be present in the RSA, as they are associated with tropical and sub-tropical areas; however, vagrants may occur in the summer months.

Table 6.29 Marine Mammal and Sea Turtle Species at Risk and their Likelihood of Occurrence

Species	Federal Status		Habitat and Distribution	Potential Presence
	***SARA* Schedule 1 Listing**	**COSEWIC Assessment**		
Blue Whale - Atlantic Population	Endangered	Endangered	• Found in coastal and pelagic waters, frequently at shelf edge where food production is high (Schoenherr 1991). • Present in all oceans except the Arctic (Reilly et al 2008). • Critical habitat in the estuary and Gulf of St. Lawrence is currently being identified for the species (DFO 2016b).	Present in small numbers throughout the year; most common in the winter and early spring.
Fin Whale - Atlantic Population	Special Concern	Special Concern	• Coastal shelf edge and offshore (COSEWIC 2005). • World-wide distribution; most abundant at temperate and polar latitudes (Reeves et al 2002). • Typically found in areas with high prey concentration (e.g., the Grand Banks) in the summer months.	Present year-round, most common in the summer months.
North Atlantic Right Whale	Endangered	Endangered	• Prefers waters 100 – 200 m deep with surface temperatures between 8 and 15°C (Kenney 2001). • Distribution related to presence and abundance of prey species. • Aggregate in five seasonal habitat areas along the east coast of North America, including two designated critical habitat areas in Canada: the lower Bay of Fundy and Roseway Basin on the Scotian Shelf (Brown et al 2009).	Uncommon in the area; may be present in the summer months.
Northern Bottlenose Whale	Endangered (Scotian	Special Concern	• Deep-diving species found in waters 800 - 1500 m deep.	Potentially present in small numbers in the

Species	Federal Status		Habitat and Distribution	Potential Presence
	***SARA* Schedule 1 Listing**	**COSEWIC Assessment**		
- Davis Strait population; Scotian Shelf population	Shelf population)	(Davis Strait population) Endangered (Scotian Shelf population)	• In western North Atlantic, occur from Baffin Island to New England (Taylor et al 2008a). • It is unclear to which population individuals observed in the RSA belong; however, a recent observation of 50 individuals in the Sackville Spur area suggest there may be a previously unknown population (CBC 2016). • Davis Strait population seemingly tends to migrate north to south, although patterns are not consistent (Reeves et al 1993), whereas Scotian Shelf population is apparently non-migratory. • Three marine canyons, all along the Scotian Shelf, have been identified as critical habitat for the Scotian Shelf population (DFO 2010b).	area year round; most sightings have been in the spring and summer. The Scotian Shelf population is believed to be non-migratory; therefore, they are considered unlikely to be present.
Sowerby's Beaked Whale	Special Concern	Special Concern	• Deep-diving species found at continental edges and slopes in depths of 550 - 1500 m or more. • Seasonal movements unknown. • Found in cold North Atlantic waters, from Massachusetts to Labrador (Taylor et al 2008b).	May be present year round in deep water habitats.
Beluga Whale (St. Lawrence Estuary population)	Threatened	Endangered	• Coastal species (ACS 2006). • Concentrated near the outlet of the Saguenay River in summer; in the winter months, they disperse from estuarine habitats, regularly occurring as far downstream as the western end of Anticosti Island (COSEWIC 2014). • Critical habitat has been identified in the St. Lawrence Estuary and lower reaches of the Saguenay River (DFO 2012a).	Very rare in the area; seldom range far from the St. Lawrence estuary.
Killer Whale (Northwest Atlantic / Eastern Arctic population)	none	Special Concern	• Nearshore and pelagic environments. • Cosmopolitan distribution, concentrated in areas of high productivity (Forney and Wade 2006).	Likely present; small numbers have been observed in the area at all times of year.

Species	Federal Status		Habitat and Distribution	Potential Presence
	***SARA* Schedule 1 Listing**	**COSEWIC Assessment**		
Harbour Porpoise	none	Special Concern	• Coastal shelf, bays and estuaries, but occasionally offshore (Hammond et al 2008). • Found in cold waters throughout the northern hemisphere (Hammond et al 2008). • Seasonal movements poorly known.	Fairly common in the area, possibly present year round.
Walrus	none	Special Concern	• Require shallow open areas with substrate supporting a productive bivalve community, and suitable ice or land nearby upon which to haulout (COSEWIC 2006). • Once common in the Atlantic Provinces, but now restricted to Arctic to sub-Arctic regions.	Extremely unlikely. Single extralimital report in RSA (OBIS 2017).
Leatherback Sea Turtle (Atlantic population)	Endangered	Endangered	• Typically found in coastal shelf waters with depths of less than 200 m. • Range from tropical to sub-polar regions (COSEWIC 2012), and undertake extensive migrations between feeding areas and to tropical nesting areas (Wallace et al 2013). • To date, critical habitat has not been identified; however, DFO (2012b) observed three high-use feeding areas in Canadian waters: 1) waters east and southeast of Georges Bank, including the Northeast Channel near the southwestern boundary of the Canadian Exclusive Economic Zone; 2) the southeastern Gulf of St. Lawrence and waters off eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel; and 3) waters south and east of the Burin Peninsula, Newfoundland, including parts of Placentia Bay. Information from the DFO study is being used to inform the	Occur with some regularity in the area, mainly from April to December.

Species	Federal Status		Habitat and Distribution	Potential Presence
	***SARA* Schedule 1 Listing**	**COSEWIC Assessment**		
			identification of critical habitat in a forthcoming amendment to the species' Recovery Strategy (DFO 2013a).	
Loggerhead Sea Turtle	Endangered	Endangered	• Found in oceanic and near-shore zones of temperate and tropical Atlantic, Pacific and Indian Oceans, and nest on beaches in subtropical and tropical climates (COSEWIC 2010). • In Atlantic Canada, most abundant in spring to fall, and generally associated with the Gulf Stream.	Uncommon; most frequently observed in the spring and summer months.

6.3.6 Important Areas and Times for Marine Mammals and Sea Turtles

Baleen whales are present in the area throughout the year, but are most abundant in the summer months. Most species are migratory and absent from the area in winter, but common minke whale and blue whale may occur in the area year-round. Most toothed whales are thought to be year-round residents of the RSA, with the exception of Risso's and common bottlenose dolphins, which are found only in the summer months, and beluga, which are only observed in the winter months. Pinnipeds are most abundant in the winter months, although grey and harbour seals may be present year-round. Sea turtles are most abundant in the area during the summer months, when the Grand Banks and surrounding waters provide important feeding habitat, and they are absent from the area between December and April.

From Figures 6.45 to 6.48, it is evident that the greatest concentration of marine mammal sightings reported in DFO and OBIS datasets was in the Southern Grand Banks area and within the 200 nautical mile limit, while most sea turtle sightings were south of the Grand Banks and off the continental shelf edge. However, as noted at the beginning of this chapter, the level of search effort was not consistent over the entire region and so this does not necessarily reflect the specific distribution of the species. Despite these caveats, however, some species seemed to favour certain areas; for example, a relatively large proportion of fin whale sightings were clustered off the northeast coast of Newfoundland, while humpback whale sightings were somewhat widespread in coastal and continental shelf waters, but were particularly abundant on the Tail of the Grand Banks.

As described earlier, a number of EBSAs have been identified by DFO within the Placentia Bay Grand Banks Large Ocean Management Area (Templeman 2007). Among the criteria for the identification, evaluation and selection of these important areas was their importance to marine mammals and seabirds in terms of biodiversity, density and importance for reproduction and survival. Table 6.30 provides an overview of the key relevant characteristics of EBSAs located within or near the Project Area itself as they relate to marine mammals and/or sea turtles; the location of these and other EBSAs are depicted in Section 6.4.1.

Table 6.30 EBSAs and their Relevance to Marine Mammals and Sea Turtles

EBSA Name	Location	Relevance to Marine Mammals and Sea Turtles
Southeast Shoal and Tail of the Banks	Defined as the area east of 51°W and south of 45°N, extending to the edge of the Grand Banks	• Offshore spawning area for capelin and sandlance, key prey species for marine mammals. • High concentration of forage species draws large and diverse aggregations of marine mammals, especially humpback whale and northern bottlenose whale. • In terms of fitness consequences, an important seasonal foraging area for seabirds and cetaceans.
Lilly Canyon-Carson Canyon	From 44.8°N to 45.6°N along the 200 m isobaths of the southeast slope of the Grand Bank	• Important seasonal refuge and feeding area for overwintering marine mammals, particularly along the edge of the shelf.
Northeast Shelf and Slope	Northeastern Grand Bank, starting at the nose of the Bank, from 48°W to 50°W, and from the edge of the shelf to the 1000 m isobath	• Moderate fitness consequences as a potentially important marine mammal feeding area. • Important areas for marine mammals, including harp seals around the Sackville Spur west, hooded seals around Sackville Spur east, and long-finned pilot whales throughout the EBSA.
Sources: Templeman (2007), DFO (2013a), AMEC (2014), DFO (2016c)		

Critical habitat has been identified in the federal recovery strategies for the beluga (St. Lawrence Estuary population), northern bottlenose whale (Scotian Shelf population) and the North Atlantic right whale. The North Atlantic right whale's critical habitat is located in the Grand Manan Basin within the Bay of Fundy, and off southern Nova Scotia at Roseway Basin (DFO 2014). Critical habitat for the beluga (St. Lawrence Estuary population) is restricted to the St. Lawrence estuary (DFO 2012a), and critical habitat for the northern bottlenose whale (Scotian Shelf population) is located in three deep underwater canyons off the southern coast of Nova Scotia, along the Scotian Shelf (DFO 2010b). Researchers have recently discovered at least 50 northern bottlenose whales in the Sackville Spur area; this significant find (in size, numbering 30 percent or more of the entire Scotian Shelf population) is thought to potentially represent a previously undiscovered population of the species (CBC 2016). Recovery strategies identifying critical habitat are not currently available for the other species at risk reported in the RSA. A study intended to aid in the identification and delineation of critical habitat for the blue whale is underway; recent studies have identified important feeding grounds in the estuary and Gulf of St. Lawrence, and these will be used to inform the identification of critical habitat areas (Beauchamp et al 2009; DFO 2016b).

DFO (2012b) observed three high-use feeding areas of the leatherback turtle: 1) waters east and southeast of Georges Bank, including the Northeast Channel near the southwestern boundary of the Canadian Exclusive Economic Zone; 2) the southeastern Gulf of St. Lawrence and waters off eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel; and 3) waters south and east of the Burin Peninsula, Newfoundland, including parts of Placentia Bay. Information from the DFO tracking study is being used to inform the identification of critical habitat in a forthcoming amendment to the species' Recovery Strategy (DFO 2013a).

6.4 Special Areas

A number of marine and coastal areas in Newfoundland and Labrador have been designated as protected under provincial, federal and/or other legislation or agreements due to their ecological, historical or socio-cultural characteristics and importance. Other areas have been formally identified as being special or sensitive through relevant processes and initiatives. Previous sections of this chapter have presented a description of the existing biophysical environmental setting, including marine fish and fish habitat, marine and migratory birds and marine mammals and sea turtles (including species at risk).

This section identifies and describes any associated special areas within and around the Project Area and larger RSA, which in many cases have been identified because of their ecological characteristics, importance and value, as well as associated marine uses. In addition to focusing primarily on the Project Area itself, it also provides a general overview of identified special areas within the overall Eastern Newfoundland Offshore Area (including the identified LSA and RSA for this VC, Section 11.1) and coastal areas, in order to provide overall context, and to illustrate the general proximity of the Project to these areas in the larger surrounding environment.

6.4.1 Federally Designated Areas

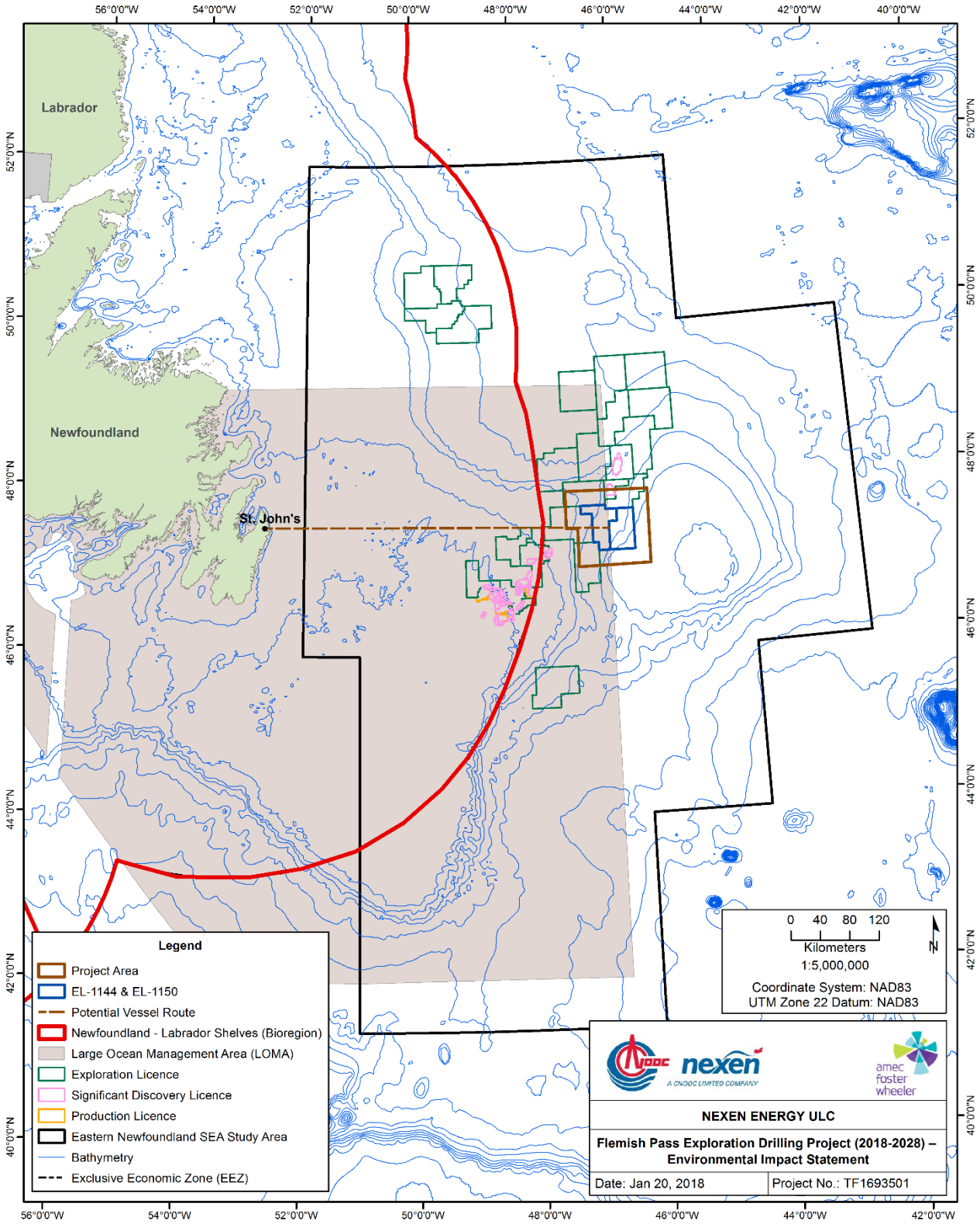
In Canada, various pieces of legislation and other processes are used to protect and conserve marine ecosystems. The following sections discuss Canada's management framework and specific measures used to identify and protect special areas in marine and coastal locations.

6.4.1.1 Bioregions and Large Ocean Management Areas

Canada's Oceans Strategy (2002) outlines the federal government's approach to marine conservation through integrated resource management. Fisheries and Oceans Canada (DFO) has defined 13 bioregions based on oceanographic and bathymetric similarities as important factors in defining marine habitats and as the ecological base for ocean resource management decisions (DFO 2002; Government of Canada 2011). Newfoundland and Labrador coastal and marine areas are included within two of these bioregions: 1) the Gulf of St. Lawrence and 2) the Newfoundland and Labrador Shelves (Figure 6.50). Within Canada's marine bioregions, DFO has identified five priority large ocean management areas (LOMAs) that exhibit important living and non-living marine resources, areas of high biological diversity and productivity combined with increasing development pressures and competition for ocean space and resources. Conservation strategies in these areas involve an integrated planning approach from all levels of government, Indigenous groups, industry organizations, environmental and community groups and academia (DFO 2002).

Eastern and southern Newfoundland are included within the Placentia Bay / Grand Banks (PB/GB) LOMA, which includes more than 500,000 km^2 of nearshore and offshore areas of the Grand Banks (GOC 2011). The PB/GB LOMA Secretariat includes provincial and federal government departments and agencies, Indigenous groups and stakeholders such as coastal communities, which have regulatory or economic interests within the PB/GB LOMA. This group has prepared an integrated management plan that addresses ecological, social, cultural and economic considerations with regard to resource use (PB/GB LOMA Secretariat 2012).

Figure 6.50 Bioregion and Large Ocean Management Area



6.4.1.2 Ecologically and Biologically Significant Areas

DFO identifies EBSAs to provide a focus on marine areas with particularly high ecological or biological activity (DFO 2005). Identification as an EBSA does not give an area regulatory protection, but rather informs processes that may eventually lead to protection or other management measures. Eleven EBSAs have been identified within the PB/GB LOMA through a ranking process using criteria of fitness consequence, aggregations, uniqueness, naturalness and resilience (Templeman 2007). In addition, 15 EBSAs have been identified in the Newfoundland and Labrador Shelves Bioregion outside of the PB/GB LOMA (DFO 2013b).

DFO has recently undertaken a process to re-evaluate the PB/GB LOMA EBSAs to align with the process that was used to delineate the Newfoundland and Labrador Shelves Bioregion EBSAs. An atlas of these EBSAs, which compiles all spatial data that will be considered in the development of a Marine Protected Area (MPA) network, is in preparation (M. Abbott, pers comm 2016; DFO 2016a).

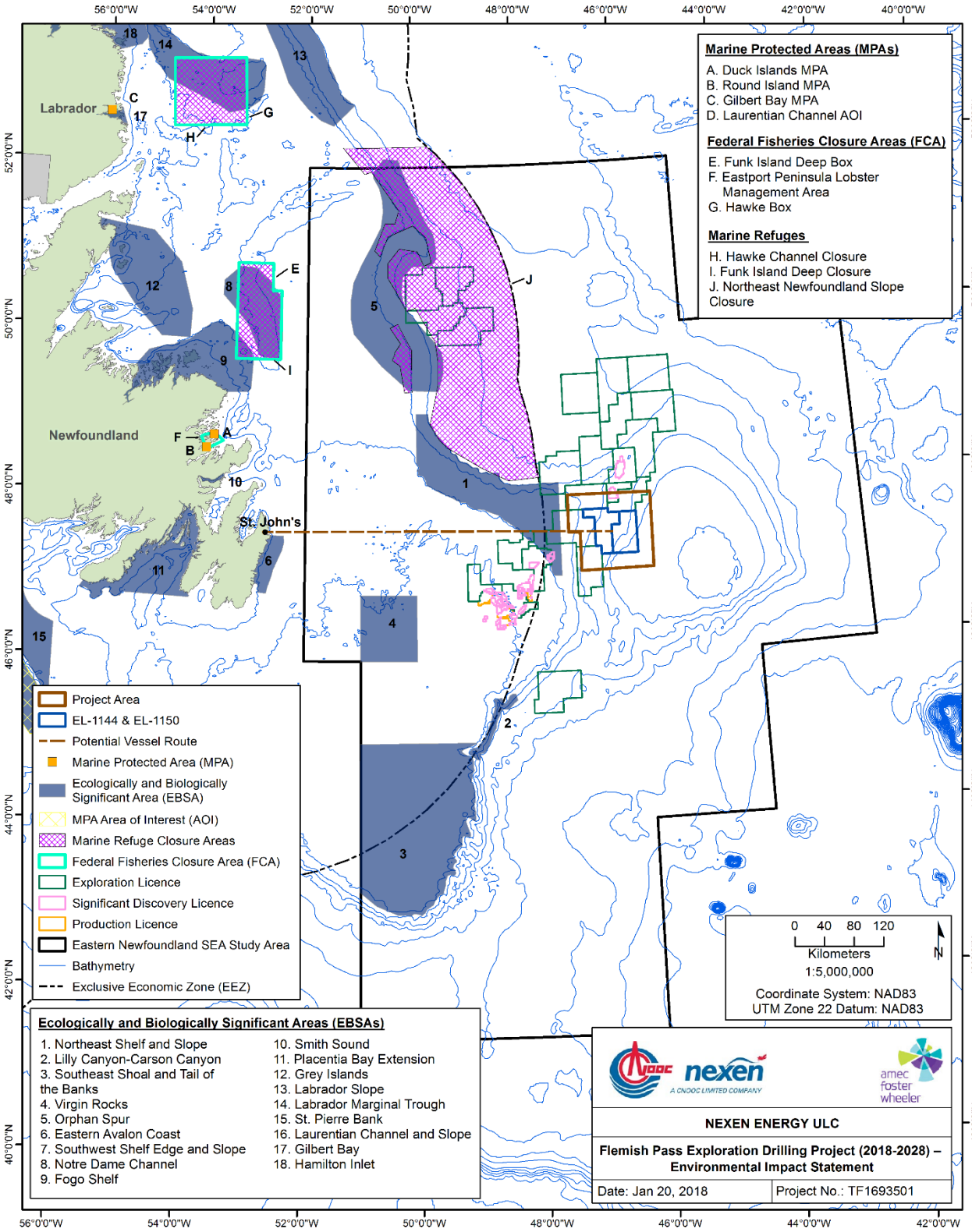
A number of EBSAs are located in marine and coastal areas of Eastern Newfoundland (Table 6.31). Various EBSAs are located in the general vicinity of the Project Area but none overlap (Figure 6.51).

Table 6.31 EBSAs off Eastern Newfoundland

EBSA	Rationale for Identification/Designation	Area
Northeast Shelf and Slope	High aggregations of Greenland halibut and spotted wolffish which congregate in spring. Concentrations of cetaceans, pinnipeds and corals.	13,885 km^2
Lilly Canyon-Carson Canyon	Concentration, reproduction and feeding area for Iceland scallop. Aggregation and refuge/overwintering for cetaceans and pinnipeds.	1,145 km^2
Southeast Shoal and Tail of the Banks	Highest benthic biomass in the Grand Banks; aggregation, feeding, breeding and/nursery habitats for capelin, yellowtail, cetaceans, seabirds, American plaice and Atlantic cod. Reproduction of striped wolffish. Unique populations of particular species. Unique sandy habitat with important glacial history.	30,935 km^2
Virgin Rocks	High aggregations of capelin and other spawning groundfish such as Atlantic cod, American plaice and yellowtail flounder. Seabird feeding areas. Unique geological features and habitat.	6,843 km^2
Orphan Spur	High concentrations of corals. Densities of sharks and species of conservation concern (e.g. northern, spotted and striped wolffish, skates, roundnose grenadier, American plaice, redfish).	21,569 km^2
Eastern Avalon Coast	Seabird feeding areas. Cetaceans, leatherback turtles and seals feed in the area from spring to fall.	1,683 km^2
Southwest Shelf Edge and Slope	Critical to a wide variety of seabirds, providing the highest density of pelagic seabird feeding within the PB/GB LOMA. Many marine mammals and leatherback sea turtles aggregate in summer.	16,644 km^2
Notre Dame Channel	Recognized for cetacean feeding and migration. Frequented by several species of seabirds. Harp seals feed in the area during winter.	6,222 km^2
Fogo Shelf	Funk Island, the largest common murre colony in the western North Atlantic and the only northern gannet breeding colony in the Newfoundland and Labrador Shelves Bioregion. Other bird species aggregations. Abundance of beach and sub-tidal capelin spawning areas. Important cetacean feeding areas. Several areas of marine mammals presence.	9,403 km^2
Smith Sound	Atlantic Cod use the area for spawning and nursery grounds and as an overwintering refuge.	148 km^2

EBSA	Rationale for Identification/Designation	Area
Placentia Bay Extension	High level of biodiversity. Supports important seabird breeding areas and a high biomass of birds and mammals. High aggregation of cetaceans and leatherback sea turtles in the spring and summer. Otters and harbour seals use area year round. Important feeding area from spring to fall for many seabird species and cetaceans (especially humpbacks and porpoises). Important for reproduction of many seabird species, harbour seals and otters. Possible migratory path for leatherback turtles.	7,693 km^2
Gilbert Bay	Important habitat of genetically distinct Gilbert Bay Atlantic cod species. An MPA was established in 2005. Habitat of Arctic char and Atlantic salmon. Capelin spawning area.	359 km^2
Grey Islands	Important for waterfowl and seabirds in coastal areas and on the shelf. Common eider and harlequin duck occur in high concentrations. Important breeding colonies for great black-backed gulls, herring gulls and terns. High diversity of seabird species aggregate along the inner shelf area.	11,301 km^2
Labrador Slope	High diversity of corals, sponges, rare or endangered species, core species and fish functional groups. Rare or endangered species: Atlantic, spotted and northern wolffish. Significant concentrations of roundnose grenadier, skates, northern shrimp, Greenland halibut, redfish, Atlantic cod and American plaice.	29,746 km^2
Labrador Marginal Trough	Core fish species and various marine mammals. High densities of shrimp, snow crab, Greenland halibut, American plaice, witch flounder and capelin. Potential corridor for several fish and mammal species. Part of the highest probability of use for harp seal whelping and feeding. Aggregations of plank piscivores, and small and medium benthivores. Aggregations of cetaceans in summer and fall. Important for seabirds including murres, black-backed kittiwake, great black-backed gull, herring gull, northern fulmar, Atlantic puffin, skuas, jaegers, Sooty Shearwater and the endangered Ivory Gull.	16,952 km^2
St. Pierre Bank	Highest and only concentration of sea scallops on the Grand Banks. High concentration of spiny dogfish and northern most extent of the species. Feeding areas for cetaceans.	5,482 km^2
Laurentian Channel and Slope	The sole pupping grounds of black dogfish off Canada. Important juvenile/nursery area for smooth skates. Used by cetaceans moving in and out of the Gulf of St. Lawrence.	17,140 km^2
Hamilton Inlet	Habitat of capelin, Atlantic salmon and seabirds. Capelin spawning areas. Harp seal whelp on pack ice in the area. Fall and winter feeding area for ringed seals. Important area for a number of species of seabirds, waterfowl, gulls and fulmars including species of special concern: the harlequin duck.	11,038 km^2
Southern Pack Ice	Seasonal pack ice recognized for its importance to marine mammals and seabirds.	n/a
Source: Templeman (2007); DFO (2013b); Amec (2014); DFO (2016c)		

Figure 6.51 EBSAs, MPAs. Marine Refuges and Federal Fisheries Closure Areas



6.4.1.3 Marine Protected Areas and Areas of Interest

Through Canada's *Oceans Act*, DFO is mandated with establishing a network of Marine Protected Areas (MPAs) in Canada. An MPA designation provides protection for marine ecosystems and their resources in areas that are ecologically important, and which contain species and/or properties that require special consideration. The first step in MPA establishment is the identification of Areas of Interest (AOI), which undergo detailed evaluation and public consultation before a decision is made concerning formal designation. Certain activities are prohibited within MPAs and for the existing Newfoundland and Labrador MPAs these include: disturbing, damaging, destroying or removing living organisms or habitat; or depositing, discharging or dumping substances that may have the same result (DFO 2016).

The Government of Canada has issued draft regulations for the proposed Laurentian Channel Marine Protected Area (i.e., Laurentian Channel AOI) for public comment (DFO 2017). The results of the consultation process have not yet been released.

Several MPAs and one AOI are located in coastal waters off Newfoundland (Bonavista Bay and off the south coast) and Labrador (Gilbert Bay) (Table 6.32). None of the MPAs are found within or near the Project Area (Figure 6.51) as the nearest AOIs are located off the south coast of Newfoundland, Cape Breton, Nova Scotia and in the Gulf of St. Lawrence.

Table 6.32 MPAs and AOI in Newfoundland and Labrador

MPA / AOI	Rationale for Identification/Designation	Area
Eastport – Duck Islands MPA	Established in 2005 to limit fishing with an aim to ensure a viable American lobster population and to protect threatened or endangered species.	2.1 km^2 on two islands
Eastport-Round Island MPA		
Gilbert Bay MPA	Established in 2005 to conserve one of the few coastal concentrations of northern cod in the Newfoundland region and to indirectly protect other species and habitats.	60 km^2
Laurentian Channel AOI	Designated as an AOI in 2010. Highest concentration of black dogfish and only pupping area in Canadian waters. Important spawning, nursing and feeding area for variety of species including porbeagle shark and smooth skate. Critical migration route for marine mammals moving in and out of Gulf of St. Lawrence. Two Species at Risk (i.e., northern wolffish and leatherback sea turtle) found in area. One of the highest concentrations of sea pens (soft feather-shaped corals) in the Newfoundland and Labrador Shelves Bioregion.	11,619 km^2
Source: EMPAAC (2013); DFO (2016c, 2017a)		

6.4.1.4 Marine Refuges

In December 2017, DFO established seven new Marine Refuges of the coasts of Nunavut and Newfoundland and Labrador (Table 6.33). These include areas of the Funk Island Deep and Hawke Channel previously identified as Federal Fisheries Closure Areas as well as an area of the Northeast Newfoundland Slope. Prohibiting bottom-contact gear can protect not only the corals and sponges but also a diversity of other species of fish and invertebrates that use the structural habitat that corals and sponges provide. These areas can act as natural refuge areas that may contribute to increased species

productivity, which in turn, could potentially lead to increased abundance within and adjacent to the area (DFO 2017b).

Table 6.33 Marine Refuges off Eastern Newfoundland

Closure Area	Designation	Area
Funk Island Deep Closure	Designated to conserve important benthic habitat for Atlantic cod, diverse groundfish populations and other commercially important species (e.g., snow crab). Overlaps with Notre Dame Channel EBSA. Prohibitions for bottom trawl, gillnet and longline fishing.	7,274 km^2
Hawke Channel Closure	Designated to protect benthic habitat for Atlantic cod, high diversity of groundfish populations and other sensitive (e.g., Atlantic wolffish) and commercial (e.g., snow crab, Greenland halibut). Overlaps with Labrador Marginal Trough EBSA. Prohibitions for bottom trawl, gillnet and longline fishing activities.	8,837 km2
Northeast Newfoundland Slope Closure	Designated to contribute to long-term conservation of biodiversity by protecting coral and sponge habitat. Dense aggregations of large, structure-forming cold-water corals provide niche space for other organisms. Overlaps with Orphan Spur EBSA that supports high diversity, including depleted species (e.g. Roundnose Grenadier). Prohibitions for all bottom contact fishing activities.	46,833 km^2
Source: DFO (2017b)		

6.4.1.5 Fishing Closure Areas within Canada's Exclusive Economic Zone

A number of areas off Eastern Newfoundland have been closed to particular types of fishing activities to help conserve productive fish and shellfish habitat for commercially fished species. Lobster fishing is limited in the Eastport Peninsula Lobster Management Area in Bonavista Bay through the *Fisheries Act* and two portions of the area are designated as MPAs under the *Oceans Act* (EMPACC 2013). An area of the Hawke Channel off Labrador is protected under the *Fisheries Act* as a no-trawl/no-gillnetting study area. An area of the Funk Island Deep off Eastern Newfoundland is closed to gillnetting and small vessel bottom trawling under the *Fisheries Act*, and voluntarily closed (by the fishing industry) to the large vessel shrimp fleet. The fishing industry and/or DFO are engaged in research and monitoring activities in these areas (DFO 2007). Aside from the noted fishing restrictions, no other resource extraction activities are prohibited in these areas with the exception of within the MPAs, as noted previously.

Two of the fishing closure areas are located in coastal and nearshore areas of Eastern Newfoundland (Table 6.34). None are located within or near the Project Area (Figure 6.51).

Table 6.34 Federal Fisheries Closure Areas off Eastern Newfoundland

Closure Area	Rationale for Identification/Designation	Area
Eastport Peninsula Lobster Management Area	In 1995, Eastport Peninsula lobster fishers voluntarily limited lobster fishing in an area of Bonavista Bay to protect prime lobster habitat. In 1997, DFO provided protection through the *Fisheries Act* and designated two portions of the area as MPAs under the *Oceans Act*.	400 km^2
Funk Island Deep Box	In 2002, DFO closed (through the *Fisheries Act*) an area of the Funk Island Deep to gillnetting to protect bottom habitat. DFO also closed the area to small vessel bottom trawling in 2005. The fishing industry has voluntarily closed the area to the large vessel shrimp fleet.	7,272 km^2

Closure Area	Rationale for Identification/Designation	Area
Hawke Box	In 2002 at the request of local fishers, DFO closed a portion of the Hawke Channel to trawling and gillnetting (under the Fisheries Act) and expanded the area in 2003. The area remained open to seasonal snow crab pot fishing. Closure was a precautionary measure primarily to sustain the crab fishery and secondarily to conserve cod known to aggregate there.	8,610 km^2
Source: DFO (2007, 2014); EMPAAC (2013)		

A number of other areas of Newfoundland waters have been voluntarily closed to fishing to improve habitat productivity for particular commercial species. Lobster fishing has been prohibited, within a total area of 94 km^2 in seven Lobster Area closures, to protect lobster spawning habitat and increase egg production. In Eastern Newfoundland, Lobster Area closures include Gooseberry Island, Glover's Harbour, Mouse Island and Gander Bay (DFO 2017c). Crab fishing has been prohibited in a number of areas. In Eastern Newfoundland, these include exclusion zones for the 3NLO Inshore Fleet for areas of the Southern Shore (Avalon Peninsula), Bonavista Bay, Trinity Bay, Conception Bay and the Eastern Avalon Peninsula, and in an area off the south coast of the Avalon Peninsula for the Small Supplementary Fleet (DFO 2011).

6.4.1.6 National Marine Conservation Areas and Preliminary Representative Marine Areas

Parks Canada establishes National Marine Conservation Areas (NMCAs), under the Canada *National Marine Conservation Areas Act*, as general marine areas managed for ecologically sustainable use and with specific zones of protection. NMCAs include the seabed, the water column above it and may also encompass wetlands, estuaries, islands and other coastal lands. Conservation is the principal goal of NMCA designation, but fishing activities are permitted (Parks Canada 2017). Prohibited activities include exploration and extraction of hydrocarbons, minerals, aggregates and other inorganic matter (Government of Canada 2015). The Saguenay-St. Lawrence Marine Park is the only NMCA on Canada's Atlantic coast, but the Governments of Canada and Quebec have undertaken a study on creating an NMCA in Îles-de-la-Madeleine, Quebec (Parks Canada 2017). No NMCAs have yet been established in Newfoundland and Labrador or elsewhere in Atlantic Canada.

Parks Canada's long-term goal is to establish at least one NMCA in each of its 29 Marine Regions that encompass all of Canada's coastlines: Pacific Ocean, Arctic Ocean, Great Lakes and Atlantic Ocean. To achieve this, the agency has begun a process of identifying preliminary Representative Marine Areas (RMAs). Along with scientific study, formal establishment is subject to consultations with governments, stakeholders and the public. Atlantic Canada has 10 marine regions including those that encompass the coast of Newfoundland and Labrador, namely the Labrador Shelf, the Newfoundland Shelf, the Grand Banks, the Laurentian Channel and the Northern Gulf Shelf (Parks Canada 2017).

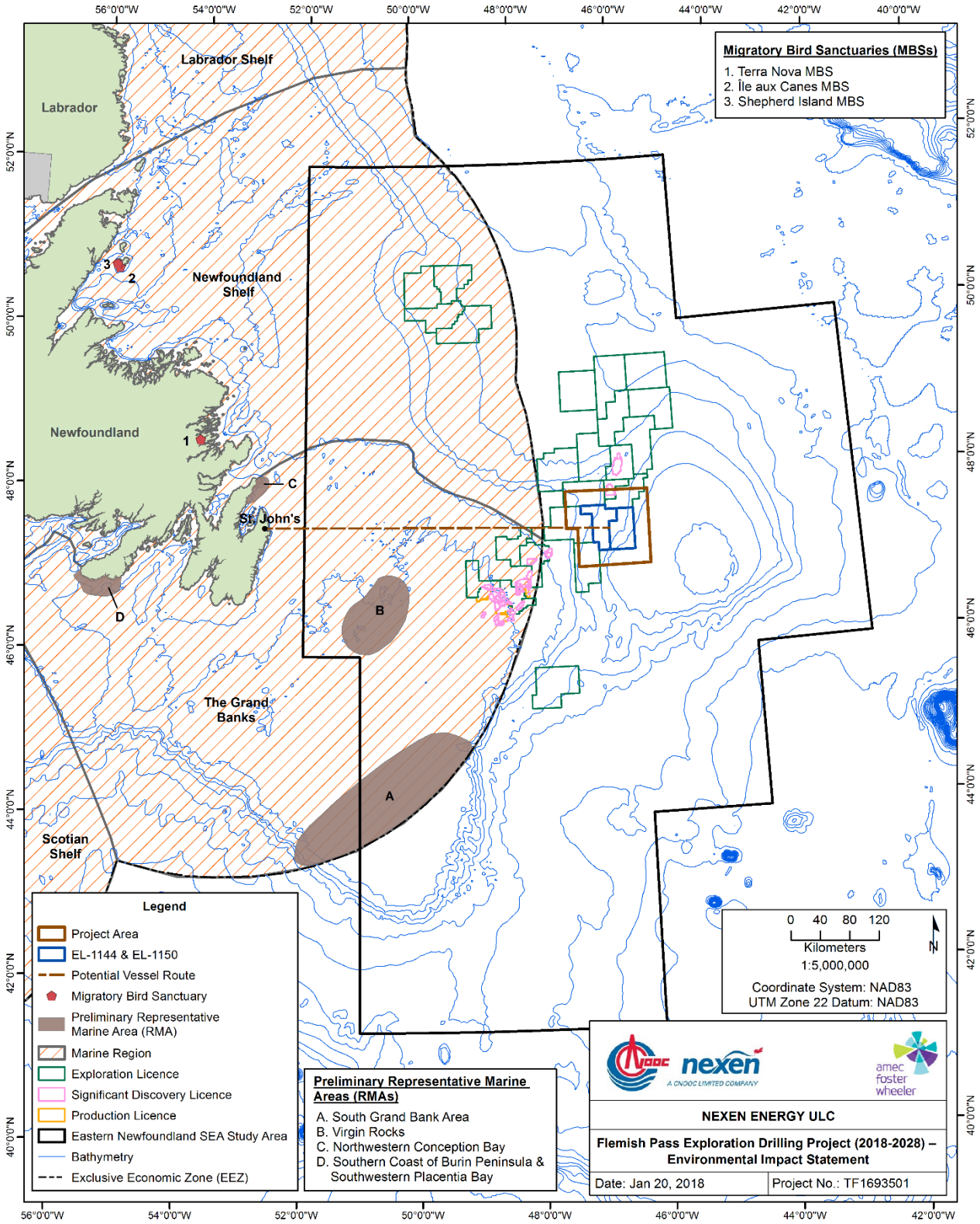
While no NMCAs have been established in any of the Marine Regions around Newfoundland and Labrador, several organizations have recommended protection of special biophysical features that support marine life and productive fisheries in the Grand Banks area (Fuller and Myers 2004; CPAWS 2009). Parks Canada has identified preliminary RMAs within the Grand Banks Marine Region and these areas may coincide with special areas (e.g., Baccalieu Island, Lawn Bay and Fortune Head provincial ecological reserves and Virgin Rocks and Lilly Canyon-Carson Canyon EBSAs) identified and/or

protected through other processes (Table 6.35). None of the RMAs are located within the Project Area (Figure 6.52).

Table 6.35 Preliminary RMAs off Eastern Newfoundland

Preliminary RMA	Rationale for Identification/Designation	Area
Virgin Rocks	Unique geological features and habitat within the PB/GB LOMA. Important spawning habitat for Atlantic cod, American plaice and yellowtail flounder. Congregation area for capelin. Congregation and feeding area for seabirds. Large winter colonies of common eiders.	6,740 km^2
South Grand Bank Area	Relatively high coral species richness. High fish species richness. Significant groundfish biomass. Unique species biodiversity including seabirds, Fea's petrel and other rare birds. Feeding area for aggregations of seabirds, cetaceans and leatherback turtles.	18,201 km^2
Northwestern Conception Bay	Capelin spawn in high concentrations. Greatest abundance and diversity of seabird species in Eastern North America. Largest seabird island and greatest diversity of breeding seabirds in the province. Largest Leach's storm petrel breeding colony in the world. One of six known breeding colonies of Northern Gannets in North America. One of four islands in Eastern Canada where northern fulmars breed.	608 km^2
Southern Coast of Burin Peninsula and Southeastern Placentia Bay	Globally significant concentrations of seabirds such as Leach's storm petrel. Largest concentration of nesting Manx shearwaters in North America and the only North American location where the species nests regularly. Other seabirds and gulls nest in the area.	1,357 km^2
Source: CPAWS (2009); Amec (2014)		

Figure 6.52 Preliminary RMAs and MBSs



6.4.1.7 National Wildlife Areas, Marine Wildlife Areas and Migratory Bird Sanctuaries

Through the *Canada Wildlife A*ct, the Government of Canada has established 54 National Wildlife Areas (NWA), on federally-owned lands, for the purposes of wildlife conservation, research and interpretation. These areas, some of which are relatively undisturbed, protect approximately one million hectares of nationally significant plant and animal habitats, with nearly half of the total area protecting marine habitats. No NWAs are located in Newfoundland and Labrador (the nearest are in Cape Breton, Nova Scotia and the Northumberland Strait, New Brunswick) (Environment Canada 2016). Thus no NWAs are located in or near the Project Area.

In 1994, the Canada *Wildlife Act* was amended to allow for the identification of Marine National Wildlife Areas (MWAs) beyond the 12 nautical mile territorial sea limit out to the extent of Canada's 200 nautical mile EEZ. No MWAs have yet been designated in Canada, but candidate sites such as the Scott Islands off the coast of British Columbia are being evaluated (Environment Canada 2016). Thus no MWAs are located or proposed within or near the Project Area.

MBSs are designated under the *Canada Wildlife Act* to protect marine and migratory bird habitats used for feeding, breeding and as sanctuaries during spring and fall migration. Permitted activities are limited to low impact recreation and potentially other activities that are compatible with conservation (Government of Canada 2010). No MBSs are located in Labrador. On the Island of Newfoundland, two MBSs are located on the east coast of the Northern Peninsula and one in Terra Nova National Park (Table 6.36). None of these MBSs are located within or near the Project Area (Figure 6.52).

Table 6.36 MBSs in Newfoundland and Labrador

MBS	Rationale for Identification/Designation	Area
Terra Nova	Designated in 1967 to protect an area adjacent to Terra Nova National Park. About 30 shorebird, waterfowl and seabird species. Important sanctuary during fall migration. Shorebirds frequent tidal flats during summer and early fall. Newman Sound is an important area for waterfowl species year round.	12 km^2
Île aux Canes	Designated in 1991 to protect nesting colonies of common eider. Together with Shepherd Island, one of the largest breeding sites for the common eider in insular Newfoundland.	1.62 km^2
Shepherd Island	Designated in 1991 to protect one of the largest breeding sites (together with Île aux Canes) for common eider in insular Newfoundland.	0.18 km^2
Source: Environment Canada (2016)		

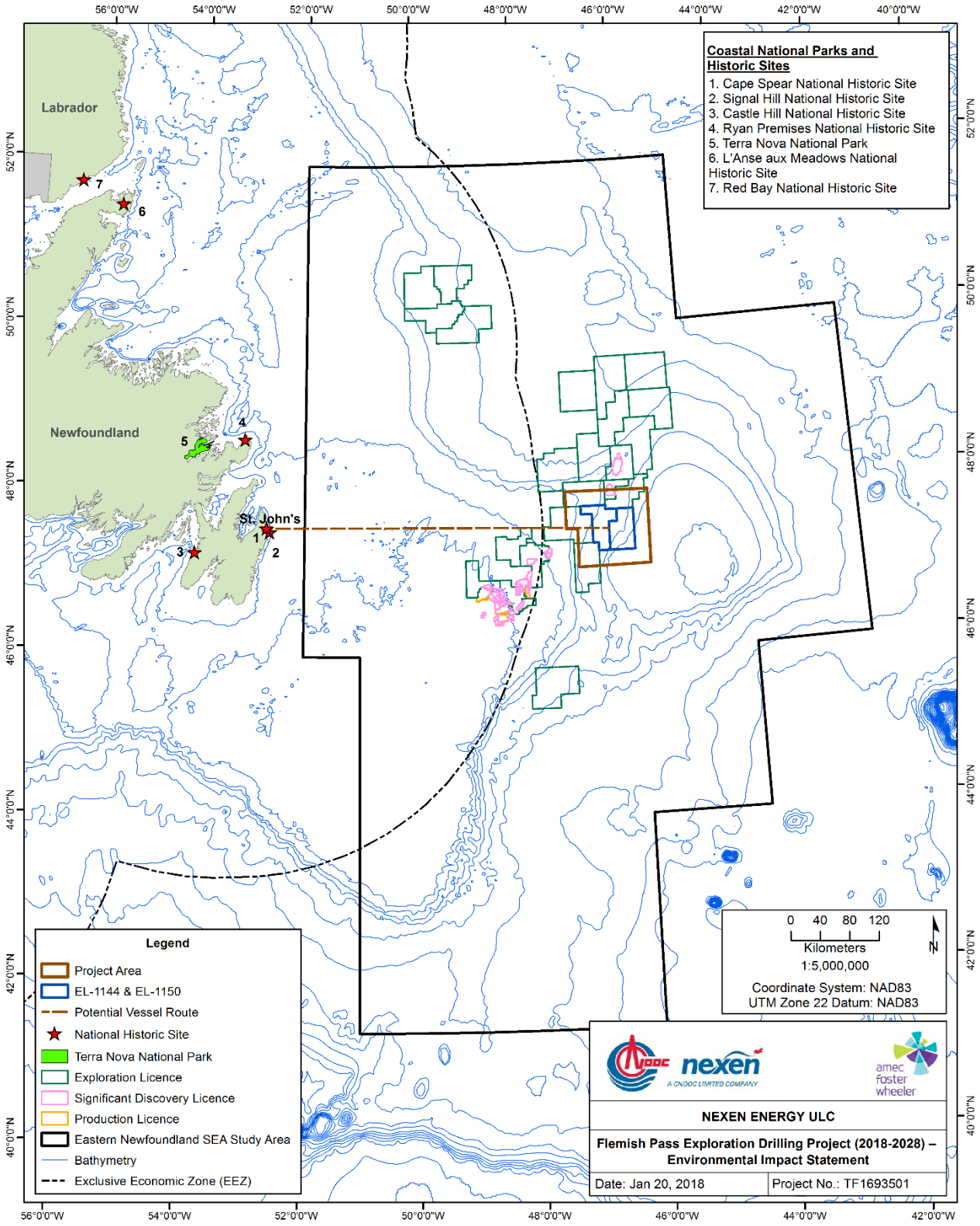
6.4.1.8 National Parks and Historic Sites

Parks Canada establishes National Parks (under the *National Parks Act*) to protect representative examples of Canada's 39 National Parks Natural Regions. Two national parks have been established on the Island of Newfoundland: Gros Morne and Terra Nova. In addition, the Torngat Mountains National Park is located in northern Labrador and the Mealy Mountains National Park Reserve is located in southeastern Labrador (Parks Canada 2009). Gros Morne is located on the west coast of Newfoundland. Terra Nova National Park, along with various National Historic Sites (NHSs), designated through the *Historic Sites and Monuments Act*, are located in coastal areas of Eastern Newfoundland (Parks Canada 2016) (Table 6.37). No national parks or historic sites are located within or near the Project Area (Figure 6.53).

Table 6.37 Coastal National Parks and Historic Sites in Eastern Newfoundland

Park/National Historic Site	Rationale for Identification/Designation	Area
Cape Spear National Historic Site	Restored historical lighthouse and lighthouse keepers home on most eastern point of North America.	n/a
Signal Hill National Historic Site	Historic site of wireless communication and military defence of St. John's Harbour.	n/a
Ryan Premises National Historic Site	Restored merchant's premises, displaying artifacts focusing on traditional Newfoundland seafaring life.	n/a
Terra Nova National Park	Protects 400 km2 of boreal forest and rocky coastlines as a representative example of Natural Region 35: Eastern Newfoundland Atlantic Region.	n/a
Castle Hill National Historic Site	Restored site of 17th and 18th century French and English fortifications representing battles over Newfoundland fisheries resources.	n/a
Source: Amec (2014); Parks Canada (2008, 2016)		

Figure 6.53 Coastal National Parks and National Historic Sites



6.4.2 Provincially Designated Areas

The Government of Newfoundland and Labrador, through the Department of Municipal Affairs and Environment (MAE), establishes and manages six types of provincial protected areas, each of which is designed to fulfill conservation and/or cultural mandates. The Parks and Natural Areas Division of MAE is responsible for wilderness and ecological reserves and provincial parks, and the Wildlife Division manages wildlife reserves and a nature park. The Province has also undertaken scientific analysis and stakeholder consultation towards developing a Draft Protected Areas Strategy to enhance its protected areas network, but to date has not yet released this plan (DOEC 2016).

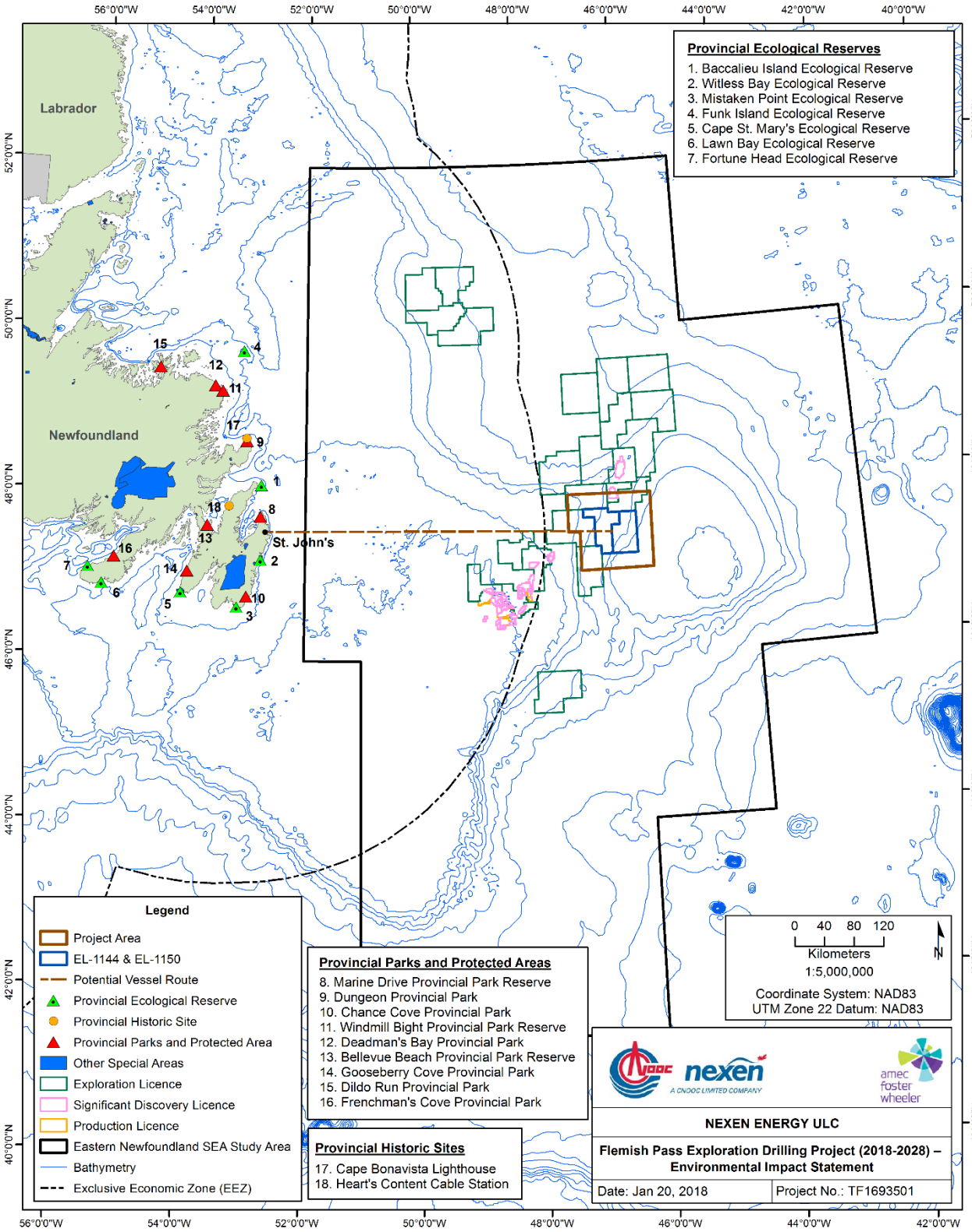
6.4.2.1 Wilderness and Ecological Reserves

Through the *Wilderness and Ecological Reserves Act*, the Provincial Government establishes and manages a series of wilderness and ecological reserves, which are created to protect and conserve wildlife, wilderness and biodiversity. The *Seabird Ecological Reserve Regulations* and *Fossil Ecological Reserve Regulations* protect many of these areas and limit activities to learning, research and passive recreation (DOEC 2016a). In Eastern Newfoundland, these special areas include five seabird ecological reserves and two fossil ecological reserves, which are located in marine and coastal areas (Table 6.38). None of these reserves are located within or near the Project Area (Figure 6.54).

Table 6.38 Coastal Provincial Ecological Reserves in Eastern Newfoundland

Reserve	Rationale for Identification/Designation	Area
Baccalieu Island Seabird Reserve	Established as a provisional ecological reserve in 1991, to protect breeding seabird habitat, and granted full status in 1995. Has more breeding seabirds than any other area of the province. Largest Leach's Storm Petrel colony in the world. Second largest Puffin colony in North America.	22.9 km^2
Witless Bay Seabird Reserve	Established as a wildlife reserve in 1964 and designated as an ecological reserve (under new legislation) in 1983. Large number of bird species. North America's largest Puffin colony. Second largest Leach's Storm-Petrel colony in the world.	30.5 km^2 on four islands
Mistaken Point Fossil Reserve	Established as a provisional ecological reserve in 1984 to protect fossils of the Earth's oldest complex life forms. Permanent designation in 1987. Reserve area expanded in 2009. Designated a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site in 2016.	5.7 km^2
Funk Island Seabird Reserve	Established as a wildlife reserve in 1964 to protect the largest colony of common murre in the Western North Atlantic. Designated as an ecological reserve (under new legislation) in 1983.	5.4 km^2
Cape St. Mary's Seabird Reserve	Established as an ecological reserve in 1993 to protect major breeding seabird colonies. More than 65,000 birds in breeding season (April to October). Offshore waters are important wintering area for a number of duck species.	66.8 km^2
Lawn Bay Seabird Reserve (Middle Lawn, Swale, and Colombier Islands)	Established as a provisional ecological reserve in 2009, to protect the habitat of thousands of nesting seabirds, and granted full status in 2015. Significant colony of Leach's storm petrel. Middle Lawn Island is the only known colony of Max Shearwater in North America.	3.8 km^2 on three islands
Fortune Head Fossil Reserve	Established as a provisional ecological reserve in 1990, to protect fossils representing the geological boundary between the Precambrian Era and the Cambrian Period, and granted full status in 1992.	2.4 km^2
Sources: Amec (2014); DOEC (2016a); UNESCO (2016)		

Figure 6.54 Provincial Protected and Special Areas



6.4.2.2 Parks and Protected Areas

Through the *Provincial Parks Act* and regulations, the Government of Newfoundland and Labrador maintains a network of provincial parks and provincial park reserves to protect representative natural areas and scenic features and/or to provide recreational opportunities and amenities. Provincial parks and protected areas are intended for conservation, research and recreational use. Where harvesting activities are permitted, these are limited to fishing and hunting (DOEC 2016b). Existing provincial parks and protected areas that are located in coastal areas of Eastern Newfoundland are listed and described in Table 6.39. None are located within or near the Project Area (Figure 6.54).

Table 6.39 Coastal Provincial Parks and Protected Areas in Eastern Newfoundland

Park / Protected Area	Rationale for Identification/Designation	Area
Marine Drive Provincial Park Reserve	Protects an area representative of the Northeastern Barrens Subregion. Park Type: Reserve.	6.17 km^2
Dungeon Provincial Park	Protects a beach with a collapsed sea cave and natural archway carved by sea action. Natural or scenic attraction. Park Type: Day use.	0.02 km^2
Chance Cove Provincial Park	Protects a large area including the coast where one can view whales, seabirds and seals. Natural or scenic attraction. Park Type: Day use.	20.68 km^2
Windmill Bight Provincial Park Reserve	Protects a plateau bog as an element of provincial Ecoregion 7. Park Type: Reserve.	2.86 km^2
Bellevue Beach Provincial Park Reserve	Protects a sand and beach-rock bar, saltmarsh and barachois habitat used by migrating shorebirds. Park Type: Reserve.	1.16 km^2
Deadman's Bay Provincial Park	Protects a sandy beach. Iceberg watching. Natural or scenic attraction. Park Type: Day use.	0.70 km^2
Gooseberry Cove Provincial Park	Protects a sandy beach with grassy back shore. Natural or scenic attraction. Park Type: Day use.	0.05 km^2
Dildo Run Provincial Park	Protects a rocky coastline with rolling hills and valleys. Park Type: Camping.	3.28 km^2
Frenchman's Cove Provincial Park	Protects an area adjacent to a large barachois, sand and mud flats, mixed forest and tidal lagoons. Diverse population of shore birds and waterfowl. Park Type: Camping.	0.51 km^2
Source: DOEC (2016b)		

6.4.2.3 Historic Sites

The Government of Newfoundland and Labrador designates Provincial Historic Sites, through the *Historic Resources Act*, because of their historical or architectural significance. These sites may be open to the public for interpretation purposes or are sometimes preserved and protected and therefore not available to visitors. Cultural and palaeontological resources related to Historic Sites are protected under the Act and may not be moved, damaged or altered. A number of these sites are found in coastal areas of Eastern Newfoundland (Table 6.40), none of which are located within or near the Project Area (Figure 6.54).

Table 6.40 Coastal Provincial Historic Sites in Eastern Newfoundland

Historic Site	Rationale for Identification/Designation	Area
Cape Bonavista Lighthouse	Historic lighthouse, built in 1843, includes traditional seal oil fueled catoptric light apparatus used in the 1800s. Also demonstrates the work of light keepers of the period.	n/a
Heart's Content Cable Station	The first permanent telegraph cable between Europe and North America was connected at this site in 1866. Displays communications technology used until the 1960s.	n/a
Source: DBTCRD (2016)		

6.4.3 Internationally Designated Areas

This section describes special areas that are either in areas of international jurisdiction or are considered to be of global importance. In coastal and marine areas of Eastern Newfoundland, these areas include identified vulnerable marine ecosystems (VMEs) of which portions are protected through Canada's *Fisheries Act*. Also, various coastal and inland areas of Eastern Newfoundland have been identified as globally, continentally or nationally significant bird habitats.

6.4.3.1 Vulnerable Marine Ecosystems

The Food and Agricultural Organization (FAO) of the United Nations (UN) is mandated by member countries to oversee the management and utilization of food resources, including marine fisheries. The FAO works with regional fishery bodies (RFBs) to sustainably manage seafood resources and habitats in marine areas beyond national jurisdictions. NAFO is the RFB responsible for fisheries beyond the EEZ off Canada's east coast. NAFO includes 12 member nations from North America, Europe, Asia and the Caribbean that collaborate on fisheries management within the NAFO regulatory area. NAFO members are required to comply with binding international legal instruments, such as the:

- United Nations Convention on the Law of the Sea (UNCLOS)
- United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UNFSA)
- Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (Compliance Agreement)
- Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (Port State Measures Agreement)

In 2007, the UN General Assembly (UNGA), through Resolution 61/105, paragraph 83, adopted the vulnerable marine ecosystem (VME) concept as an approach to the regulation and management of deep sea fisheries in areas that extend beyond national jurisdictions. In keeping with this Resolution, the FAO prepared International Guidelines for the Management of Deep-sea Fisheries in the High Seas (DSF Guidelines) to provide criteria for identifying and delineating VMEs. VME designation is based on the sensitivity of an ecosystem and the vulnerability of its population, communities or habitats to the impacts of fishing activities where bottom fishing gear is likely to contact seafloors during the normal course of fishing operations (FAO 2016a).

NAFO's Working Group on the Ecosystem Approach to Fisheries Management (WG-EAFM) was initiated in 2008 to identify and delineate VMEs within its regulatory footprint (FAO 2016a). In 2013, the WG-EAFM became the Working Group of Ecosystem Science Assessment (WG-ESA). The identification of VMEs is based on the presence of VME indicator species such as corals and sponges as well as topographical, hydrophysical and geological features (e.g., seamounts, hydrothermal vents and sponge fields) that form physical and structural elements of marine ecosystems. In addition, coral and sponge communities act as nurseries, refuges and as spawning and breeding grounds for many species (WG-EAFM 2008; FAO 2016a).

Several types of VME indicator elements and species have been identified in the NAFO Regulatory Area (NAFO 2017; WWF 2012). These include the following:

- Physical VME indicator elements such as seamounts, canyons, knolls, shoals and steep flanks; and

- Benthic invertebrate VME indicator species including many from taxonomic groups such as large-sized sponges, stony corals, small gorgonian corals, large gorgonian corals, sea pens, tube-dwelling anemones, erect bryozoans, sea lilies (crinoids) and sea squirts.

The WG-ESA has identified nine areas containing VME indicator species and features in NAFO Divisions off Eastern Newfoundland (WG-EAFM 2008; WWF 2012; FAO 2016a) (Table 6.41). These VME areas themselves are not protected, although portions of them are and other sites may eventually receive protection through NAFO processes (WG-EAFM 2008). Several VMEs are located in offshore Newfoundland near the Project Area but none overlap (Figure 6.55).

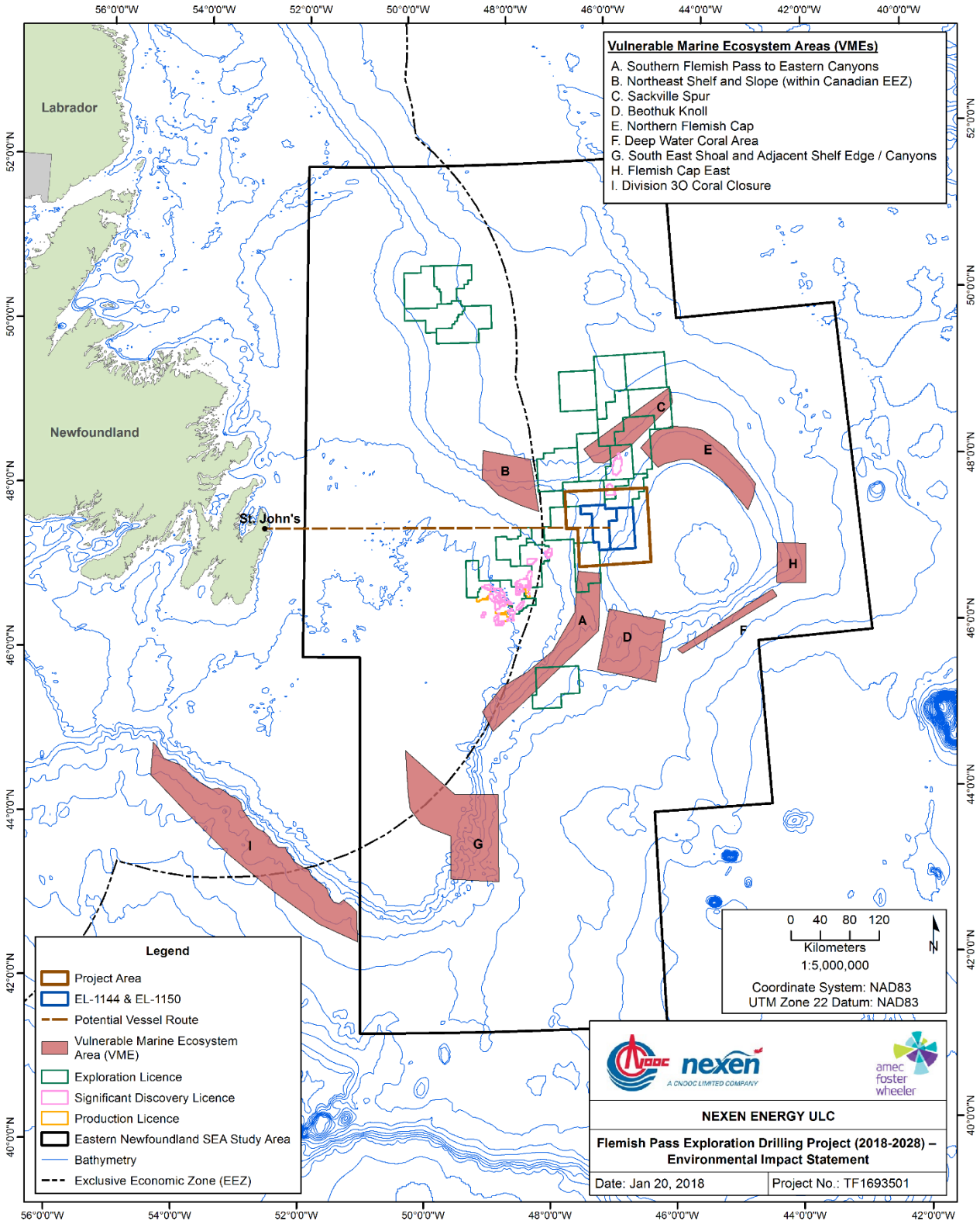
Table 6.41 VMEs off Eastern Newfoundland

VME	Rationale for Identification/Designation	Area (Apx)
Southern Flemish Pass to Eastern Canyons	Large gorgonians and high density of sponges. Vulnerable fish species: striped wolffish, redfish, spiny tailed skate, northern wolffish, some black dogfish, deep sea cat shark.	7,928 km^2
Northern Flemish Cap	High density of sea pens, soft corals and black corals and, to a lesser extent, solitary stony corals and small gorgonians. Vulnerable fish species: northern wolffish and spiny dogfish.	6,650 km^2
Sackville Spur	High density of sponges.	3,961 km^2
Northeast Shelf and Slope (within Canadian EEZ)	Abundance of gorgonian and black corals.	4,150 km^2
Beothuk Knoll	Abundant gorgonian corals and high density of sponges. Vulnerable fish species: northern wolffish, spiny tailed skate, roundnose grenadier, deep sea cat shark, black dogfish.	6,685 km^2
Deep Water Coral Area	An area where VMEs for deep-water corals are thought to be likely.	1,502 km^2
Flemish Cap East	Large gorgonians and high density of sponges. Vulnerable fish species: black dogfish and smooth skate.	2,098 km^2
South East Shoal and Adjacent Shelf Edge/Canyons	Unique spawning grounds on South East Shoal, marine mammal feeding grounds, long-lived and relict bivalve populations in sandy shoal habitat. Vulnerable fish species: spawning capelin, northern wolffish, redfish, striped and spotted wolffish, roundnose grenadier, black dogfish.	11,930 km^2

VME	Rationale for Identification/Designation	Area (Apx)
Division 3O Coral Closure Area	Existing closure based on coral concentrations, high density of sea pens and solitary stony corals. Vulnerable fish species: white hake, redfish, black dogfish, smooth skate and deep-sea cat shark.	16,877 km^2
Source: WG-EAFM (2008)		

In addition to the areas described above, NAFO has identified seamounts and other knolls (including the Orphan Knoll, Newfoundland Seamounts and Fogo Seamounts) as likely to host VME habitats, which include corals, sponges and a range of vulnerable fish species (e.g., alfonsino, orange roughy, silver roughy, wreckfish and cardinal fish) considered to be endemic in these areas (WG-EAFM 2008).

Figure 6.55 Vulnerable Marine Ecosystem Areas



6.4.3.2 NAFO Fisheries Closure Areas

As a NAFO member, Canada is signatory to international agreements such as UNCLOS and the Compliance Agreement. Within the EEZ, DFO manages Canada's NAFO commitments through the *Fisheries Act* by restricting one or more types of bottom contact fishing in particular areas. Outside of Canadian jurisdiction, DFO is responsible for the fishing activities of the Canadian fleet within the NAFO regulatory area and other fishing vessels are administered by their respective country or flag state (FAO 2016).

NAFO has established various Fisheries Closure Areas (FCAs) within VMEs to help conserve sensitive habitats for corals, sponges, seamounts and sea pens and other relevant areas or features from the effects of bottom fishing as well as for research purposes. NAFO reviews and updates FCAs on a regular basis and may amend boundaries of existing areas or add new closure areas. At present, approximately 380,511 km^2 (15 percent) of the NAFO regulatory area is closed to bottom fishing (NAFO 2016a; WG-EAFFM 2016; NAFO 2017). Portions of the Flemish Pass/Eastern Canyon (2) , Northwest Flemish Cap (10) and Northwest Flemish Cap (11) FCAs are located within the Project Area (Table 6.42 and Figure 6.56). Northwest Flemish Cap (11) FCA overlaps with Nexen EL 1150 and none of the other FCAs overlap with Nexen's ELs for this Project.

Table 6.42 NAFO Fisheries Closure Areas off Eastern Newfoundland

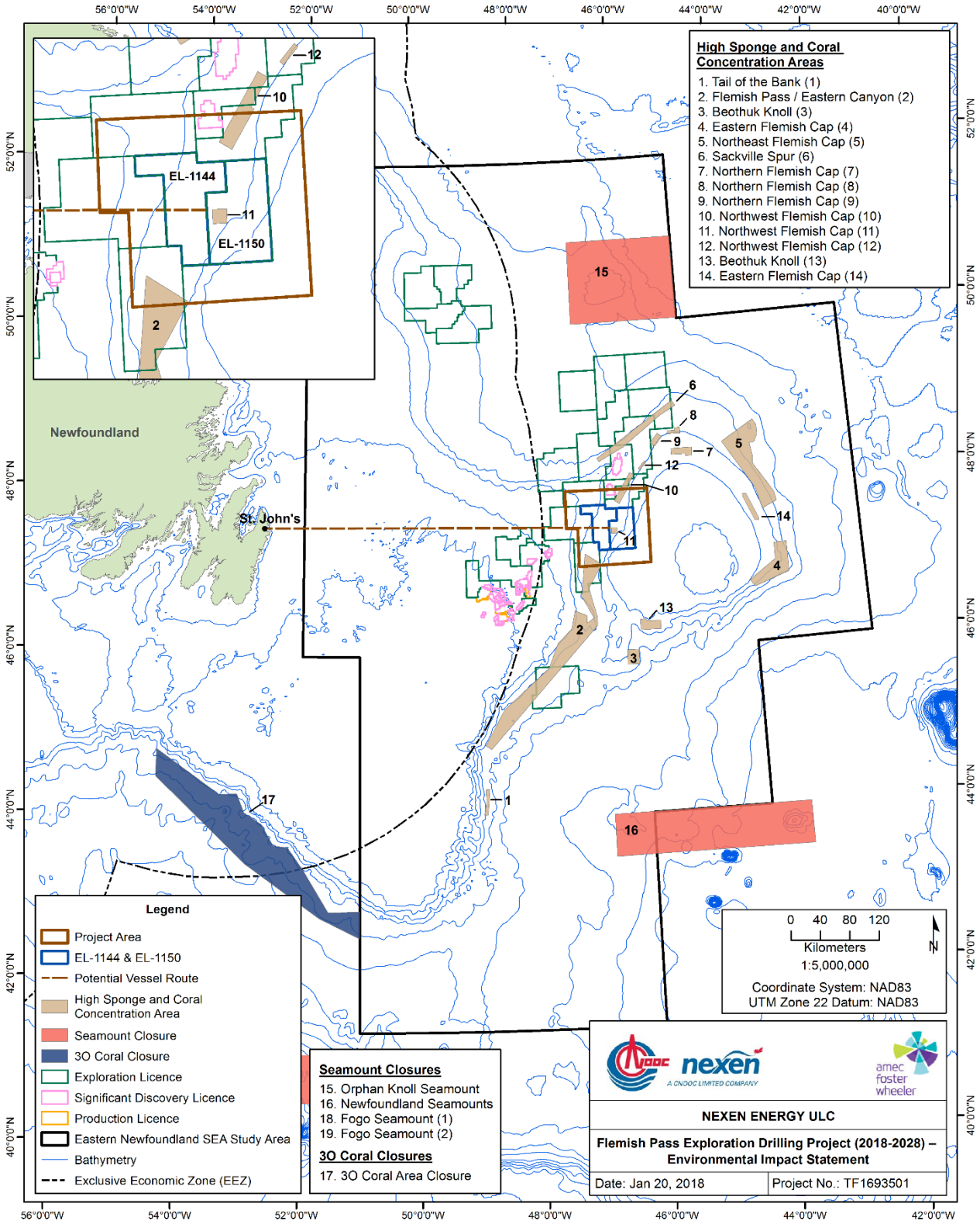
Closure Type	Closure	Rationale for Identification/Designation	Closure Period	Area
Seamount Closures	Orphan Knoll Seamount	• Orphan Knoll is a single peak, with depths of a minimum of 1,800 m with mounds at depths of between 1,800 and 2,300 m. • Physical properties indicate that mid-depth waters above Orphan Knoll are in a boundary region between outflow of the Labrador Sea (subpolar gyre) and northward flow of North Atlantic Current (subtropical gyre). West-east nutrient gradient is likely related to water mass differences between Orphan Basin and area east of Orphan Knoll. Near-bottom anti-cyclonic circulation may have important implications for benthic habitat. • The biologically rich and complex Orphan Basin/Knoll area is strongly influenced by local processes and advection. • Coral, including stony coral and sponges have been observed on the flanks of the Orphan Knoll.	January 1, 2007 to December 31, 2020	15,815 km^2
	Newfoundland Seamounts	• Includes six peaks with summits deeper than 2,400 m, and most of the area has depths greater than 3,500 m.		15,494 km^2
	Fogo Seamounts (1)	• Located southwest of the Grand Banks in depths >2,000 m. • Two of the Fogo Seamounts, both below 4,000 m depth, were closed as VME indicator	January 1, 2009 to December 31, 2020	4,522 km^2
	Fogo Seamounts (2)			4,616 km^2

Closure Type	Closure	Rationale for Identification/Designation	Closure Period	Area
		elements that have a high probability of containing VME indicator species.		
Coral Closures	3O Coral Area Closure	• Located on the continental slope from 800 m, this is the only NAFO FCA that straddles national and international waters. • The area includes mostly soft bottoms with rocky outcrops. • VME indicator elements (i.e. shelf-indenting canyons and canyons with heads > 400 m in depth) with potential VMEs. • Sea pen and small gorgonian VMEs have been identified near the FCA and species distribution models indicate a high probability of sea pens.	January 1, 2008 to December 31, 2020	13,995 km^2
High Sponge and Coral Concentration Area Closures	Tail of the Bank (1)	• This small FCA straddles the fishing footprint on the continental slope of the tail of Grand Banks around 2,000 m in depth. • Studies south of this FCA identified significant concentrations of erect bryozoans, large sea squirts (*Boltenia ovifera*) and small gorgonian VME indicator species, and crinoids and cerianthids.	January 1, 2010 to December 31, 2020	144 km^2
	Flemish Pass/Eastern Canyon (2)	• The Flemish Pass, approximately 1,200 m deep, separates the Flemish Cap from the Grand Banks. It contains sandy muds with accumulations of pebbles and stones deposited by icebergs. • Includes canyons on the eastern slope of Grand Bank, a portion of Flemish Pass in the south, and western slope of the Flemish Cap, and straddles the NAFO fishing footprint on the slopes except on the Flemish Cap. The FCA was expanded to protect large gorgonian corals in the Flemish Pass. • The area has complex hydrography owing to the occurrence of two water masses. VME indicator elements include canyons and shelf-indenting canyons. • The sponge grounds have been shown to contain high species diversity compared with non-sponge ground habitat at similar depths. Dominant sponge species include demosponges of the order Astrophorida. Geodiids (mostly Geodia barretti), Stelletta normani and Stryphnus ponderosus in deeper water. These large sponges, sometimes grow to more than 25 cm in diameter.		5,418 km^2

Closure Type	Closure	Rationale for Identification/Designation	Closure Period	Area
		• Some sponge, large gorgonians and sea pen VMEs have also been identified outside the FCA.		
	Beothuk Knoll (3)	• Beothuk Knoll is a discrete steep-sided plateau that forms an abrupt projection from the southwest edge of Flemish Cap. Adjacent sediment drifts consist of sands. • Has an iceberg turbate with isolated deep-water scours. Knolls are recognized as VME indicator elements. • Sponge and large gorgonian VMEs have been identified outside the FCA.		309 km^2
	Eastern Flemish Cap (4)	• The Flemish Cap is a plateau of approximately 200 km radius generally at 500 m isobaths except for a central sandy/muddy patch with depths of less than 150 m. • High densities of stalked crinoids, Gephyrocrinus grimaldii, with several structure-forming sponges inside the FCA. • A sponge and large gorgonian VME has been identified outside the FCA. Crinoids and cerianthids are also found in this area.		1,563 km^2
	Northeast Flemish Cap (5)	• Complexity of bottom of the Flemish Cap increases along the southern slope by numerous submarine canyons and steep cliffs, which are important VME indicator elements in this area. • Encompasses a gradient of benthic communities, transitioning from coral dominated communities at ~2,450 m depth, corals intermixed with sponges around 2,000 m, sponge dominated grounds at 1,500 m, and a diverse community of corals, sponges and other benthic taxa at approximately 1,300 m depth.	January 1, 2010 until December 31, 2020	2,892 km^2
	Sackville Spur (6)	• An elongate sediment drift extending from the Grand Banks across the northern limit of the Flemish Pass and the northern slope of the Flemish Cap. Its southern flank gently slopes toward the 900 m isobath in the Flemish Pass, and steeper northern flank extends to the floor of the Orphan Basin at 2,500 m depth. • Sponge species composition similar to Flemish Pass/Eastern Canyon (2). Upper limit of sponges is at about 1,300 m depth and extends to about 1,800 m. The sponge grounds host a high diversity and abundance of associated megafaunal species.		992 km^2

Closure Type	Closure	Rationale for Identification/Designation	Closure Period	Area
	Northern Flemish Cap (7)	• A system of sea pen VMEs extends around the edge of the Flemish Cap. Crinoids and cerianthids and black corals have been found associated with this sea pen system. Sponges, sea pens, cerianthids and crinoids are also found in the area.		259 km^2
	Northern Flemish Cap (8)			98 km^2
	Northern Flemish Cap (9)			128 km^2
	Northwest Flemish Cap (10)			317 km^2
	Northwest Flemish Cap (11)			61 km^2
	Northwest Flemish Cap (12)		January 1. 2014 to December 31, 2020	35 km^2
	Beothuk Knoll (13)	• Physical VME indicator elements include Beothuk Knoll, steep flanks and canyons with heads greater than 400 m.	January 1, 2015 until December 31, 2020	340 km^2
	Eastern Flemish Cap (14)	• Contains significant concentrations of sea pens, a VME indicator species. Three such sea pen locations have been identified.	January 1, 2017 until December 31, 2018	239 km^2
	Source: NAFO (2017; 2017a)			

Figure 6.56 NAFO Fisheries Closure Areas



6.4.4 Other Identified Special Areas

Canada is signatory to various international conventions some of which identify important wildlife habitats in coastal and marine areas. A number of these have been identified as important bird habitats and may be protected in whole or in part through provincial and national legislation.

6.4.4.1 Important Bird Areas

BirdLife International's Important Bird Areas (IBA) Program is a global effort to identify and protect the world's most critical bird habitats. BirdLife Canada has identified 597 Canadian IBAs as having worldwide, continental or national significance. Of these, 80 are located partially or wholly in NWAs or MBSs and all are included in science-based initiatives to identify, conserve and monitor a network of sites that provide essential habitat (Environment Canada 2010; Bird Studies Canada 2017).

A number of IBAs are located in coastal areas of Newfoundland and Labrador. Table 6.43 provides information on all IBAs in Newfoundland and Labrador with the exception of the Bay du Nord Wilderness Reserve, which has no coastal boundaries. These IBAs areas, which are also described in Section 6.4.4, may coincide with provincial (i.e., ecological reserves) or national (i.e., national parks or migratory bird sanctuaries) special areas as identified previously in this section. None of these IBAs are located within or near the Project Area (Figure 6.57).

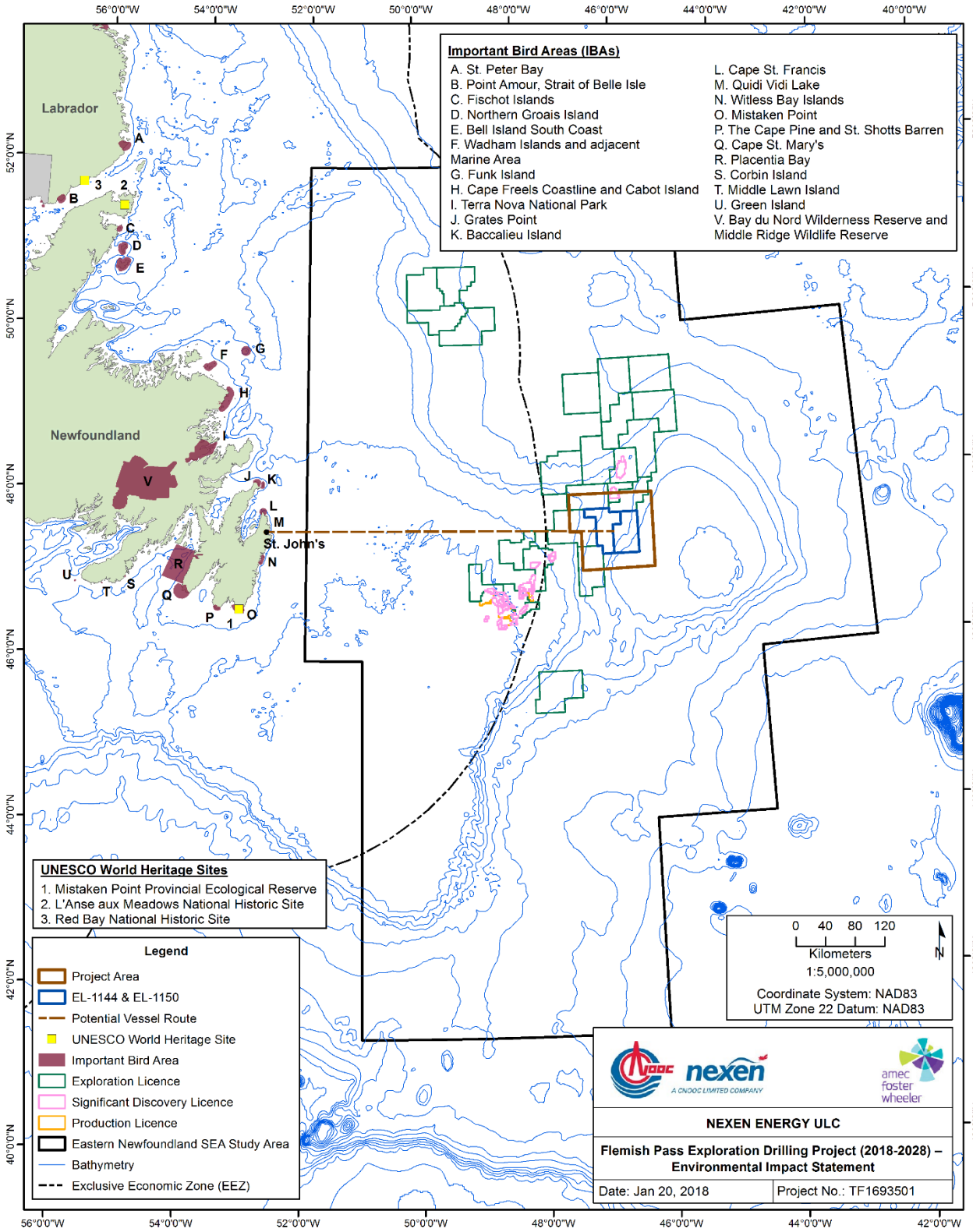
Table 6.43 Coastal Important Bird Areas in Newfoundland and Labrador

IBA	Rationale for Identification/Designation	Area
St. Peter Bay	Major moulting area for common eiders and the largest concentration of moulting eiders on the Labrador coast. In 1998, over 5,000 common eiders (approximately 6.4 percent of the Atlantic population) were recorded. Majority were of the Atlantic subspecies (*dresseri*) but some were from the northern subspecies (*borealis*). Both subspecies nest in Table Bay about 130 km to the north. Inlets and islands of St. Peter Bay are believed to be a congregation area for nationally endangered harlequin ducks. In June 1994, relatively large numbers (50 individuals or 3.3 percent of the estimated eastern North American population) were observed in what was thought to be a premoulting concentration.	170.59 km^2
Point Amour, Strait of Belle Isle	Concentration area for migrating seabirds and waterfowl. Very large numbers of birds move through a relatively small area, and few stop for an extended period of time. Seabirds and whales can be seen during the summer/fall and large numbers of Harp seals are present during migration. A 1996 spring migration survey monitored only a portion of the migration with high numbers of birds – 62,275 common eiders, 5,465 black guillemots (2 percent of the estimated global population) and 43,758 alcids (thick-billed murre, common murre, razorbills) in 5 weeks. Other species of seaducks including 398 scoters were recorded in small numbers.	107.23 km^2
Fischot Islands	A refuge area for eider ducks during severe storms. In winter, large numbers of wintering eiders congregate in open leads of water around the Fischot Islands on the lee side of the Northern Peninsula. A 1995 survey estimated the winter congregation to include about 10,000 common eiders, representing as much as 3.5 percent of the northern (spp. *borealis*) population and a small number of the Atlantic *dresseri ssp*.	56.78 km^2

IBA	Rationale for Identification/Designation	Area
Northern Groais Island	In winter, open leads of water are important for birds during both the breeding and wintering season. In spring/summer, a colony black-legged kittiwakes nest on the exposed cliffs of the Island and The Sisters Rocks. Data from the 1970s suggest that as many as 2,400 pairs (about 1 percent of the estimated western Atlantic population). During winter, larger numbers of common eiders (mostly from the northern borealis population) frequent the Island and are suspected to move between several sites in the region in response to frequently changing ice coverage conditions.	173.42 km^2
Bell Island South Coast	Open leads of water in this area are important nesting and wintering area for eiders. Bell Island, along with Groais Island, support the largest colony of nesting common eiders on insular Newfoundland, including an estimated 1,000 pairs (more than 1 percent of the estimated population) of the dresseri subspecies. During winter, large numbers of eiders from the northern (*borealis* ssp.) population congregate in the same area, with several thousand being recorded in the open water leads around the Islands. Potentially significant numbers of the eastern population of nationally endangered harlequin ducks in summer.	282.47 km^2
St. Peter Bay	Major moulting area for common eiders and the largest concentration of moulting eiders on the Labrador coast. In 1998, over 5,000 common eiders (approximately 6.4 percent of the Atlantic population) were recorded. Majority were of the Atlantic subspecies (*dresseri*) but some were from the northern subspecies (*borealis*). Both subspecies nest in Table Bay about 130 km to the north. Inlets and islands of St. Peter Bay are believed to be a congregation area for nationally endangered harlequin ducks. In June 1994, relatively large numbers (50 individuals or 3.3 percent of the estimated eastern North American population) were observed in what was thought to be a premoulting concentration.	170.59 km^2
Quidi Vidi Lake	From late fall to early spring, an important daytime resting site for gulls, including significant numbers of herring, great black-backed, Iceland, glaucous and common black-headed gulls. Ring-billed, mew and occasionally lesser black-backed gulls. Waterfowl including American black ducks, mallards and northern pintails are common in winter.	7 km^2
Cape St. Francis	Congregating area for common eiders in winter, with up to 5,000 individuals recorded. Purple sandpipers regularly seen along rocky shoreline in winter.	70.2 km^2
Baccalieu Island	Greatest seabird species abundance and diversity in Eastern North America. Largest Leach's storm-petrel colony in the world. Significant breeding populations of other seabirds. Designated as Baccalieu Island Provincial Ecological Reserve.	45.2 km^2
Witless Bay Islands	Four small islands support a globally significant colony of breeding seabirds, including more than half of the Eastern North American population of Atlantic puffins, as well as large numbers of Leach's storm-petrel, common murre, black-legged kittiwake and herring gull. During fall migration, surrounding marine area is important to sea ducks including white-winged scoter, surf scoter, long-tailed duck and common eider. Designated as Witless Bay Provincial Ecological Reserve.	62 km^2
Grates Point	Supports a large number of wintering common eiders; typically around 2,800 individuals, and as many as 12,000. Other winter species include black-legged kittiwake, thick-billed murre and dovekie. Atlantic puffin and northern gannet are found in the area in summer.	66.5 km^2

IBA	Rationale for Identification/Designation	Area
Mistaken Point	Important wintering area for common eiders, with as many as 12,000 birds. Important for wintering shorebirds. Significant numbers of purple sandpiper and small numbers of ruddy turnstone regularly overwinter. Breeding black-legged kittiwake, common murre and razorbill. Designated as Mistaken Point Provincial Ecological Reserve and UNESCO World Heritage Site for fossils.	102.8 km^2
Funk Island	Supports a very large concentration of nesting seabirds, including a globally significant common murre population, and large numbers of northern gannets. Designated as Funk Island Provincial Ecological Reserve.	135.2 km^2
Cape Freels Coastline and Cabot Island	Large number of nesting common murre and a few pairs of Razorbills. Breeding Atlantic puffins have been reported. Up to 25,000 wintering common eiders.	334.5 km^2
Terra Nova National Park	Supports numerous forest species, including two subspecies with restricted ranges: the federally-listed red crossbill and ovenbird. Shorebirds found on flats at the outlet of Big Brook, and in Newman Sound. Frequented by gulls and waterfowl. At least six tern colonies total between 1000 and 1500 pairs include both common and Arctic terns. Designated as Terra Nova National Park of Canada and Terra Nova Migratory Bird Sanctuary.	655.8 km^2
Cape Pine and St. Shotts Barren	Large, possibly globally significant, numbers of American golden-plover during their fall migration (August to mid-October). Dozens of whimbrel seen during fall migration.	57.4 km^2
Placentia Bay	Exceptional feeding area for seabirds in summer capelin spawning season; more than 100,000 shearwaters have been recorded, mostly greater and sooty shearwater, with smaller numbers of Manx shearwater. Large numbers of other species breeding at Cape St. Mary's feed here. Pomarine and parasitic jaegers may be found in large numbers. More than 1,000 common eiders regularly congregate in winter.	1398.9 km^2
Wadham Islands and adjacent Marine Area	Composed of seven main islands and several smaller rocks and shoals. Supports globally significant numbers of wintering common eiders (approximately 25,000 in a 1995 survey). Many nesting seabirds including large numbers of Atlantic puffin, Leach's storm-petrel and razorbill.	159.3 km^2
Cape St. Mary's	Significant numbers of breeding northern gannet, common murre and black-legged kittiwake, and smaller populations of other birds. Large numbers of migrating sea ducks in winter, including scoters, common eider, long-tailed duck and eastern population of harlequin duck (SARA: Special Concern). Designated as Cape St. Mary's Provincial Ecological Reserve.	329.6 km^2
Corbin Island	Supports a colony of an estimated 100,000 Leach's storm-petrels. Historically, colonies of herring gull, great black-backed gull, black guillemot and black-legged kittiwake have been reported.	5.3 km^2
Middle Lawn Island	Supports the largest, and one of the few, known colonies of Manx shearwaters in North America. As many as 100 breeding pairs have been reported, with an estimated 300 non-breeding individuals. Large numbers of breeding Leach's storm petrels. Nesting black guillemot, herring gull and great black-backed gull have been reported. Part of the designated Lawn Bay Provincial Ecological Reserve.	4.2 km^2
Green Island	Supports a large colony of Leach's storm-petrels. Breeding common and Arctic terns have been observed, as well as small numbers of herring gull. Spotted sandpipers have been reported in summer. Manx shearwaters and black guillemots are suspected to breed here.	5.6 km^2
Source: Amec (2014); Bird Studies Canada (2017)		

Figure 6.57 Important Bird Areas and UNESCO World Heritage Sites



6.4.4.2 World Heritage Sites

In 1972, UNESCO adopted the Convention Concerning the Protection of the World Cultural and Natural Heritage. This international Convention identifies and encourages conservation of cultural and natural heritage sites considered to be of outstanding value to humanity. Newfoundland and Labrador has four UNESCO World Heritage Sites (WHSs), which are managed by the provincial or federal governments (Table 6.44). None of these sites are located within or near the Project Area (Figure 6.57).

Table 6.44 World Heritage Sites in Newfoundland and Labrador

WHS	Rationale for Identification/Designation	Area
Red Bay Basque Whaling Station National Historic Site	Earliest, most comprehensive and best preserved example of a pre-industrial whaling station. Established by Basque mariners in the 16th century, the site includes land-based remains of infrastructure (buried) and underwater wrecks of whaling ships.	3.13 km^2
L'Anse aux Meadows National Historic Site	Excavated remains of an 11th century habitation are evidence of the only site established by Vikings in North America and the first European presence on the American continent.	80.56 km^2
Gros Morne National Park	Rare visible example of process of continental drift; deep ocean crust and the earth's mantle are exposed. Also outstanding examples of glaciation (e.g. fjords, glacial valleys).	1,805 km^2
Mistaken Point Provincial Ecological Reserve	The oldest known assemblages of large fossils anywhere are contained in a 17 km-long strip of rugged coastal cliffs. These marine fossils, dating to the Ediacaran Period (580-560 million years ago), illustrate the appearance of large, biologically complex organisms on earth.	1.46 km^2
Source: UNESCO (2017)		

6.4.4.3 Convention on Wetlands of International Importance

The 1971 Convention on Wetlands of International Importance (also referred to as the Ramsar Convention) established an objective of sustaining important wetland habitats throughout its network, which includes 169 countries. Canada has been a contracting party to the Ramsar Convention since 1981. To date, Canada has designated 37 Ramsar Sites of which 17 are also NWAs or MBSs (Environment Canada 2010). The only Ramsar site identified in the province is the Grand Codroy Estuary in Western Newfoundland (Ramsar Convention 2001). Thus, none are located within or near the Project Area.

6.4.4.4 Western Hemisphere Shorebird Reserve Network

The Western Hemisphere Shorebird Reserve Network (WHSRN) conservation strategy was established in 1986. North and South American scientists created the network to protect key habitats to sustain healthy populations of shorebirds. Of the seven identified Canadian sites, only one (i.e., Bay of Fundy) is located in Atlantic Canada (WHSRN 2009). Thus none are located within or near the Project Area.

6.4.4.5 The UNESCO World Biosphere Reserve Program

The UNESCO Man and Biosphere Program provides international recognition to special places nominated by their National governments, for applying interdisciplinary approaches to managing interactions between social and ecological systems, as World Biosphere Reserves (WBRs). Globally, 669 WBRs in 120 countries have received this designation. Canada has 18 WBRs located in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia (UNESCO 2016a). None are located in Newfoundland and Labrador, and thus none are located within or near the Project Area.

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7 EXISTING HUMAN ENVIRONMENT

The following sections provide an overview description of the existing human environment, with a particular focus on the various human components and activities that occur in and around the Project Area itself, and which may therefore potentially interact with, and be affected by, the Project. It also considers and describes relevant components of the existing environment in the RSA and, as relevant, in the larger offshore and coastal areas of Eastern Newfoundland in order to account for the potential environmental zone of influence of the Project and its potential effects, as well as to provide a regional context for the eventual effects analysis.

The description includes a general socioeconomic overview of the Eastern Newfoundland region, and follows the overall structure and geographic focus of the comparable section of the C-NLOPB's Eastern Newfoundland SEA (Amec 2014, see Section 4.3), and updates the information provided in that earlier report. This socioeconomic profile is provided as overall background and context, and to address the relevant portions of the EIS Guidelines which list various socioeconomic components that require consideration in the EIS. As described in Section 4.3, many of these "on land" components are not considered or included as a VC for the environmental effects assessment. This is the case given the nature and location of most planned Project components and activities, which will be over 400 km from any communities or other human activities. As a result, potential Project-related interactions with on-land or near shore aspects of the human environment such as physical and cultural heritage, human health and well-being, rural and urban settings, and other aspects of existing socioeconomic conditions in Eastern Newfoundland and beyond are not anticipated (Section 4.3).

Following this general socioeconomic overview, the majority of this chapter focusses on describing those relevant aspects of the human environment that have the potential to be affected by the Project, and which have therefore been identified and selected as a VC for the EIS – in particular, fisheries including recreational fisheries, Indigenous fisheries and fisheries research activities in the marine environment (Section 7.2) and other ocean uses. This description focusses primarily on the Project Area itself and surrounding marine environments, as well as providing regional (especially, mapping) information for the marine area between the Project Area and the Eastern Newfoundland coastline through which Project-related supply vessel and aircraft traffic are expected to transit.

The chapter also provides socioeconomic information related to Indigenous groups in Newfoundland and Labrador, the Maritime Provinces and Quebec (Section 7.4) that have been identified in the EIS Guidelines. This includes a focus on any current use of marine-associated lands and resources for traditional purposes, but also addresses each of the socioeconomic components specified in and required under CEAA 2012 (section 5(1)(c)), including health and socio-economic conditions, physical and cultural heritage, and structures, sites or things of historical, archaeological, paleontological or architectural significance.

7.1 Eastern Newfoundland – Socioeconomic Overview

Newfoundland and Labrador consists of the Island of Newfoundland (111,390 km^2), as well as Labrador (294,330 km^2), which is located to the northwest on the Canadian mainland. The total provincial population in 2016 was 519,716 persons, an increase of approximately one percent from 2011 (Statistics Canada 2017). The Island of Newfoundland comprises less than 30 percent of the province's total land mass, but is home to nearly 95 percent of its population. Residents live in approximately 250

municipalities and many unincorporated communities on the Island that range in population from fewer than five to more than 100,000 residents. These communities are widely distributed along the coastline as well as throughout the interior of the Island.

In the sections that follow, the existing human environment is described for Eastern Newfoundland as a whole (as this is the region immediately adjacent to the planned activities that comprise this Project) based on a number of subregions that have been identified for various purposes such as government administration or data collection and dissemination. The discussion of population is based on Local Areas (Figure 7.1) as defined by the NL Department of Finance's Community Accounts system, and which correspond with Statistics Canada's Census Subdivisions. For the discussion of the regional economy, the focus is on the seven relevant provincial Regional Economic Zones in Eastern Newfoundland (Figure 7.2):

1) *Economic Zone 14:* Gander - Fogo Island
2) *Economic Zone 15*: Clarenville - Bonavista
3) *Economic Zone 16*: Burin Peninsula
4) *Economic Zone 17*: Conception Bay North - Bay de Verde
5) *Economic Zone 18*: Whitbourne - St. Mary's
6) *Economic Zone 19*: Northeast Avalon
7) *Economic Zone 20*: Southern Shore - Trepassey

Although administration of the Newfoundland and Labrador Regional Economic Zone Boards has been discontinued, much of the available local and regional socioeconomic information is based on these boundaries. Thus, they are a useful focus for presentation and analyses of socioeconomic data at the regional level for the purposes of the EIS.

Figure 7.1 Local Areas in Eastern Newfoundland

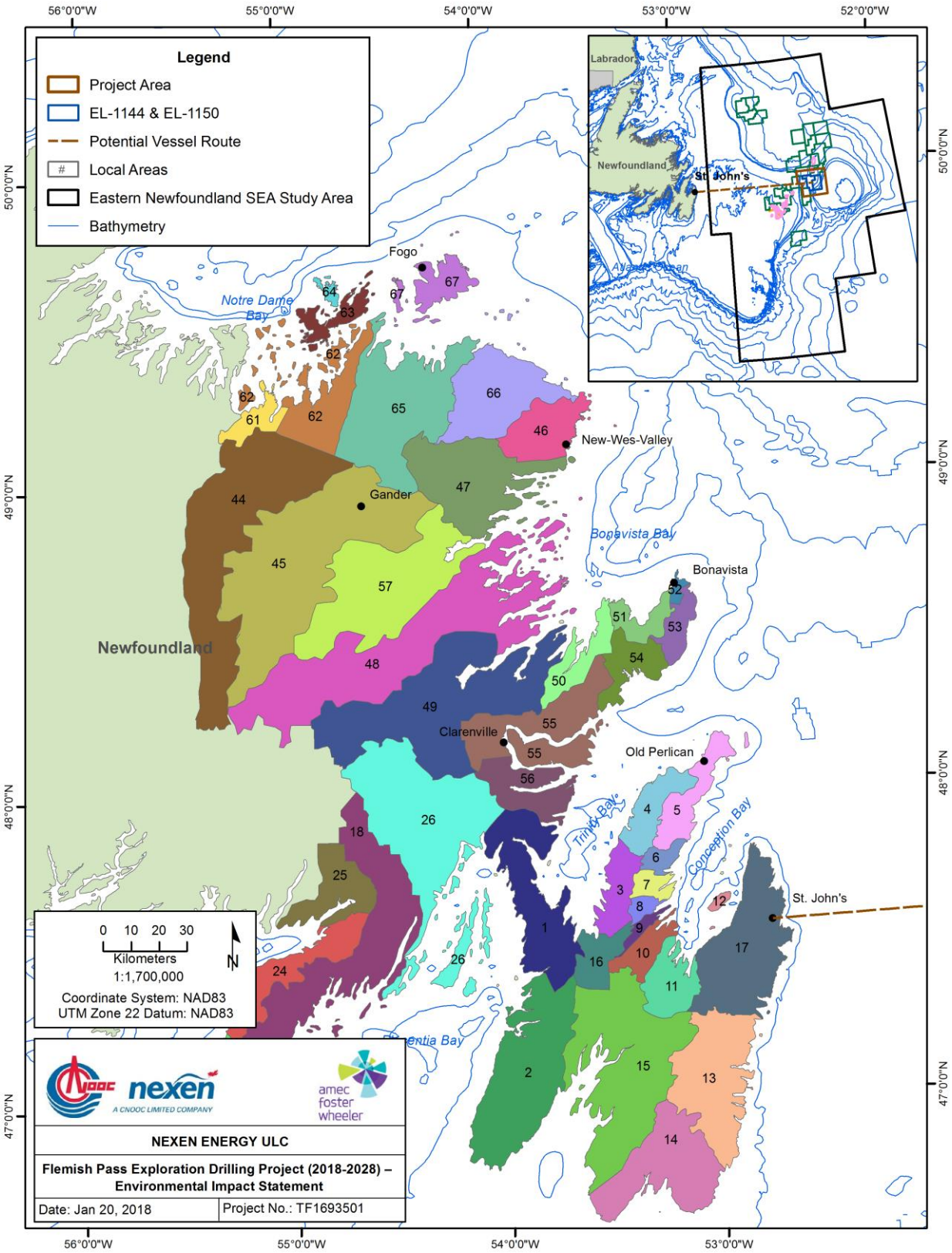
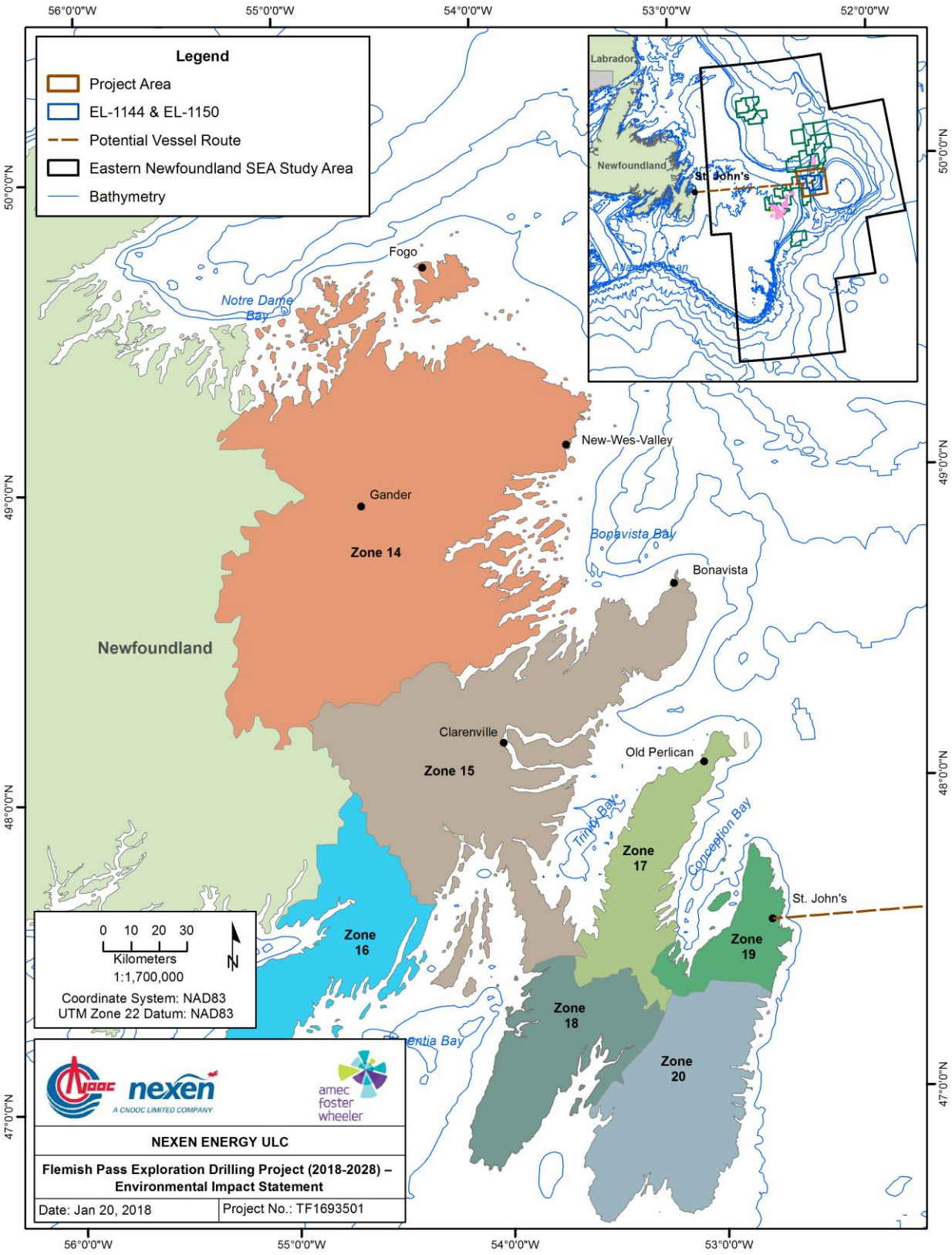


Figure 7.2 Economic Zones in Eastern Newfoundland



7.1.1 Population

The population of the Eastern Newfoundland region was approximately 354,000 persons in 2011 (NLSA 2017a) (Table 7.1). The 2016 census of population has been released by province and community but is, as of EIS writing, not yet available by region.

Most areas of the province have declining populations but the overall population of Eastern Newfoundland increased by about four percent between 2001 and 2011. Growth or stability can be seen within and around communities such as Gander, Clarenville and Bay Roberts as well as throughout the Northeast Avalon, which includes the greater St. John's area and other sub-regional service centres (NLF 2017a). Other areas are experiencing growth mainly in the residential sector due to their proximity to these centres. The population has also been stable in the Conception Bay Centre, Whitbourne and Lewisporte areas (Statistics Canada 2013).

Table 7.1 Population, Eastern Newfoundland Region

Local Area (Census Subdivisions)	2001	2006	2011	% Change (2001 to 2011)
Local Area 1: Isthmus of Avalon	5,225	4,915	4,780	-8.5%
Local Area 2: Placentia-St. Bride's Area	6,305	5,620	5,060	-19.7%
Local Area 3: Heart's Delight Area	4,360	4,155	4,200	-3.7%
Local Area 4: New Perlican-Winterton Area	2,350	2,115	1,961	-16.6%
Local Area 5: North Shore of Conception Bay	3,985	3,725	3,400	-14.7%
Local Area 6: Carbonear Area	7,980	7,780	7,815	-2.1%
Local Area 7: Harbour Grace Area	5,745	5,375	5,340	-7.0%
Local Area 8: Spaniards Bay Area	2,930	2,790	2,850	-2.7%
Local Area 9: Bay Roberts Area	5,405	5,705	6,025	11.5%
Local Area 10: Clarke's Beach Area	5,760	5,685	5,955	3.4%
Local Area 11: Head of Conception Bay	6,295	6,705	6,345	0.8%
Local Area 12: Bell Island	3,070	2,780	2,725	-11.2%
Local Area 13: Southern Shore	3,745	3,655	3,340	-10.8%
Local Area 14: Trepassey Bay	1,335	1,165	870	-34.8%
Local Area 15: St. Mary's Bay	3,055	2,780	2,395	-21.6%
Local Area 16: Whitbourne Area	2,335	2,355	2,405	3.0%
Local Area 17: Northeast Avalon	172,980	181,145	196,965	13.9%
Local Area 18: Placentia Bay West Centre	1,675	1,530	1,340	-20.0%
Local Area 19: Mortier Bay	6,765	6,220	6,280	-7.2%
Local Area 20: Burin Area	3,900	3,695	3,590	-7.9%
Local Area 21: St. Lawrence Area	1,705	1,485	1,385	-18.8%
Local Area 22: Lamaline Area	1,785	1,580	1,465	-17.9%
Local Area 23: Fortune – Grand Bank Area	5,430	4,995	4,685	-13.7%
Local Area 24: Bay L'Argent Area	1,310	1,145	1,030	-21.4%
Local Area 25: Terrenceville Area	1,140	955	935	-18.0%
Local Area 26: Placentia Bay North West	685	645	590	-13.9%
Local Area 44: Norris Arm Area	1,125	1,075	1,055	-6.2%
Local Area 45: Gander Area	11,255	11,575	12,695	12.8%
Local Area 46: Wesleyville Area	3,000	2,710	2,405	-19.8%
Local Area 47: Greenspond Area	3,550	3,415	3,370	-5.1%
Local Area 48: Alexander Bay	4,290	4,200	3,990	-7.0%
Local Area 49: Chandlers Reach	4,065	3,955	3,835	-5.7%
Local Area 50: Southern Bay Area	1,225	1,075	965	-21.2%
Local Area 51: Black Head Bay Area	790	675	635	-19.6%

Local Area (Census Subdivisions)	2001	2006	2011	% Change (2001 to 2011)
Local Area 52: Bonavista Area	4,145	3,865	3,670	-11.5%
Local Area 53: Catalina Area	2,735	2,325	2,165	-20.8%
Local Area 54: Trinity, Trinity Bay Area	1,440	1,200	970	-32.6%
Local Area 55: Smith Sound-Random Island	7,620	7,850	8,565	12.4%
Local Area 56: South West Arm Area	2,360	2,150	2,080	-11.9%
Local Area 57: Gambo Area	2,090	2,150	2,025	-3.1%
Local Area 61: Lewisporte Area	5,380	5,320	5,420	0.7%
Local Area 62: Notre Dame Bay South	2,520	2,400	2,240	-11.1%
Local Area 63: New World Island	3,700	3,430	3,170	-14.3%
Local Area 64: Twillingate Island	3,050	2,850	2,645	-13.3%
Local Area 65: Hamilton Sound	3,440	4,301	4,170	21.2%
Local Area 66: Straight Shore	2,130	1,810	1,735	-18.5%
Local Area 67: Fogo and Change Islands	2,940	2,706	2,420	-17.7%
Eastern Newfoundland Region (Total)	**340,105**	**341,737**	**353,956**	**4.1%**
Source: NLSA (2013), NLSA (2011), NLSA (2006)				

7.1.2 Economy, Employment and Business

The following sections provide a general description of the economy and associated employment and business activity in the province, again with a focus on Eastern Newfoundland (Figure 7.1).

The provincial economy has expanded in the last 20 years due to growth in both the offshore oil and gas sector (mainly in Eastern Newfoundland) and mining (primarily in Labrador). Development of natural resource extraction projects, large capital investments and subsequent royalties have been the source of strong employment, increased incomes and enhanced government revenues when commodity prices are high. Government spending has also increased due to actual and forecasted higher income from royalties. However, the provincial economy is vulnerable to global downturns especially in the price of hydrocarbons and minerals. During this expansion period, all selected provincial economic indicators continually improved until 2014 at which point they began to weaken (Table 7.2). Nonetheless, labour force participation and employment are still higher than they were in 2006 (NLF 2017b).

Table 7.2 Selected Newfoundland and Labrador Economic Indicators

Economic Indicator	2006	2011	2014	2015 (estimate)	2016 (forecast)
GDP - Market Price	$24,111 M	$27,946 M	$27,695 M	$27,047 M	$27,318 M
Labour Force - Annual Average	251,800	265,300	270,900	270,800	268,100
Employment - Annual Average	214,800	226,000	238,600	236,200	233,700
Source: NLF (2017b)					

Major capital investments in Newfoundland and Labrador were at an unprecedented high between 2010 and 2014. They have since declined but are still higher than historic levels. As ongoing large construction projects (e.g., Vale's nickel processing facility, the construction of the Hebron Project, and the Muskrat Falls Hydroelectric development) are expected to be completed in the next several years, economic activity from this construction is anticipated to slow down. In addition, the sustained decline in commodity prices has contributed to a weaker economic outlook and resulted in deferral of several proposed development projects in the province. In turn, a weaker economy in general has resulted in a decline in residential investment, with fewer housing starts and less money being spent on renovations.

These factors have all contributed to a general economic downturn in Newfoundland and Labrador (NLF 2017b).

The majority (75 percent) of major capital projects (valued at $1 million or more) in Eastern Newfoundland at present are located on the Northeast Avalon and mainly in St. John's (Table 7.3). Eastern Newfoundland, and the Northeast Avalon in particular, are affected by oil and gas exploration and development activity but the region has a diverse economy owing to the presence of other sectors including transportation, healthcare, education, government services, tourism and processing of natural resource materials.

Table 7.3 Major Capital Investment Projects in Eastern Newfoundland

Economic Zone	Projects	# Projects	Investments
14: Gander - Fogo Island	Airport improvements	1	$1.2 M
15: Clarenville - Bonavista	Oil and gas infrastructure construction	1	$14 B
	Industrial/manufacturing including: an oil refinery upgrade and nickel processing facility construction	6	$4.3 B
	Waterfront development	1	$2.5 M
16: Burin Peninsula	Aquaculture development	1	$75 M
	Mining development	1	n/a
17: Conception Bay North - Bay de Verde	Long term care home construction	1	$100.6 M
	Commercial/industrial development	1	$13-17 M
	Marine facility expansion	1	$6 M
18: Whitbourne - St. Mary's	Transshipment terminal modifications	1	$70 M
	Lift bridge replacement	1	$51.9 M
19: Northeast Avalon	Transportation including airport expansion	4	$358.3 M
	Memorial University	2	$341.2 M
	Commercial construction/redevelopment and industrial/business parks	12	$192.5 M
	Tourism/Culture/Recreation	11	$156.9 M
	Health care/personal care	6	$62.9 M
	Municipal infrastructure	5	$47.4 M
	Industrial/manufacturing	1	$1.2 M
	Other	3	$66.5 M
20: Southern Shore - Trepassey	Offshore marine base development	1	$15-20 M
Total		**60**	**$20 B**
Source: NLF (2017b)			

As of December 2015, Eastern Newfoundland had nearly 11,500 registered businesses, which is more than 70 percent of those in the province as a whole (Table 7.4) (NLF 2017c). More than half of these enterprises were located in Economic Zone 19, which includes St. John's and the Northeast Avalon.

Table 7.4 Number of Businesses, Eastern Newfoundland (2015)

Economic Zone	Number of Businesses	Percentage of Provincial Total
Zone 14: Gander-Fogo Island	1,406	8.7%
Zone 15: Clarenville-Bonavista	927	5.7%
Zone 16: Burin Peninsula	544	3.4%
Zone 17: Conception Bay North-Bay de Verde	1,086	6.7%
Zone 18: Whitbourne-St. Mary's	158	1.0%
Zone 19: Northeast Avalon	7,039	43.4%
Zone 20: Southern Shore-Trepassey	216	1.3%
Total Eastern Newfoundland	11,376	70.1%
Total Newfoundland and Labrador	16,227	100%
Source: NLF (2017a)		

The number of businesses in Eastern Newfoundland declined by two percent between 2011 and 2015, primarily due to loss of businesses engaged in the "Other Services" (minus 433 businesses) sector (Table 7.5). The decline was in part offset by increases in "Construction" (plus 193 businesses) and "Professional, Scientific and Technical Services" (plus 128 businesses) categories (NLF 2017c).

Table 7.5 Number of Businesses by Sector, Eastern Newfoundland (2011 and 2015)

Industry Sector	Number of Businesses		Change	
	2011	2015	#	%
Construction	1,581	1,774	193	12%
Professional, scientific, technical services	868	996	128	15%
Real estate and rental leasing	426	467	41	10%
Transportation and warehousing	431	450	19	4%
Arts, entertainment and recreation	217	234	17	8%
Educational services	109	122	13	12%
Accommodation and food services	826	839	13	2%
Mining and oil and gas extraction	43	50	7	16%
Utilities	7	10	3	43%
Administrative and support, waste management and remediation services	426	426	0	0%
Information and cultural industries	93	86	-7	-8%
Public administration	285	275	-10	-4%
Wholesale trade	503	486	-17	-3%
Finance and insurance	261	239	-22	-8%
Manufacturing	336	309	-27	-8%
Management of companies and enterprises	104	74	-30	-29%
Agriculture, forestry, fishing and hunting	280	247	-33	-12%
Retail trade	1,649	1,580	-69	-4%
Health care and social assistance	1,296	1,224	-72	-6%
Other services (except public administration)	1,848	1,415	-433	-23%
Total Eastern Newfoundland	11,589	11,303	-286	-2%
Source: NLF (2017c)				

The majority of businesses in Eastern Newfoundland are relatively small, with fewer than five employees (Table 7.6). Businesses that were closed between 2011 and 2015 were likewise small with 20 or fewer employees. The number of larger businesses increased during the same period. This may indicate a

degree of consolidation among firms, or the closure of some businesses and growth of others (NLF 2017c). Note that the number of businesses by employment size is lower than the number of businesses by sector due to confidentiality requirements.

Table 7.6 Number of Businesses by Employment Size, Eastern Newfoundland

Employment Size Range	Number of Businesses		Change	
	2011	2015	#	%
1 to 4 employees	6,310	6,058	-252	-4%
5 to 19 employees	3,914	3,827	-87	-2%
20 to 99 employees	1,088	1,156	68	6%
100 to 499 employees	168	170	2	1%
500 + employees	30	50	20	67%
Total	11,510	11,261	-249	-2%
Source: NLF (2017c)				

Employment and unemployment rates throughout Eastern Newfoundland vary according to the economic base in any given area (Table 7.7), with larger, regional centres typically having higher employment levels than more rural areas. In 2011, Economic Zone 19, which includes the capital city of St. John's and the Northeast Avalon, had the highest employment rate in Eastern Newfoundland. With a more diversified economy, this area has a variety of employment opportunities in organizations such as government agencies, post-secondary educational institutions and health care facilities as well as in tourism services and the commercial/retail sector. In contrast, Economic Zone 18, which has the highest unemployment rate, is a rural region with a larger seasonal workforce (e.g., fishing, seafood processing, tourism) (NLF 2017a).

Table 7.7 Labour Market Profile, Eastern Newfoundland (2011)

Economic Zone	Type	Labour Force	Participation Rate	Employment Rate	Unemployment Rate
Zone 14: Gander-Fogo Island	Rural	39,025	54.6%	43.5%	20.3%
Zone 15: Clarenville-Bonavista	Rural	23,910	54.2%	42.4%	21.8%
Zone 16: Burin Peninsula	Rural	17,635	53.7%	42.8%	20.3%
Zone 17: Conception Bay North-Bay de Verde	Rural	33,960	53.3%	44.4%	16.6%
Zone 18: Whitbourne-St. Mary's	Rural	5,435	52.5%	41.5%	21.0%
Zone 19: Northeast Avalon	Urban	168,440	66.2%	61.0%	7.9%
Zone 20: Southern Shore-Trepassey	Rural	6,840	58.4%	48.5%	17.0%
Newfoundland and Labrador	n/a	27,259,525	66.0%	60.9%	7.8%
Source: NLF (2017a)					

The majority of working residents in Eastern Newfoundland, and in the province in general, are employed in occupations related to Sales and Service followed by Trades, Transport and Equipment Operation (Table 7.8). Larger numbers of people are also employed in Education, Law, Social, Community and Government Services long with Business, Finance and Administration (NLF 2017a).

Table 7.8 Employment by Occupation, Eastern Newfoundland (2011)

Occupation / Sector (Select)	Zone 14: Gander-Fogo Island	Zone 15: Clarenville - Bonavista	Zone 16: Burin Peninsula	Zone 17: Conception Bay North-Bay de Verde	Zone 18: Whitbourne-St. Mary's	Zone 19: Northeast Avalon	Zone 20: Southern Shore-Trepassey	Province
Sales and Service	20%	26%	19%	20%	18%	23%	15%	22%
Trades, Transport and Equipment Operation	19%	24%	25%	21%	21%	12%	23%	18%
Business, Finance, Administration	10%	9%	8%	10%	12%	18%	14%	13%
Education, Law, Social, Community and Government Services	15%	11%	15%	14%	12%	14%	12%	13%
Management	8%	7%	6%	7%	11%	10%	7%	8%
Natural and Applied Sciences	6%	4%	5%	4%	8%	9%	6%	7%
Health	7%	5%	7%	8%	4%	8%	6%	7%
Natural Resources and Agriculture	8%	5%	8%	6%	9%	1%	9%	5%
Manufacturing and Utilities	7%	9%	7%	9%	4%	2%	8%	5%
Art, Culture, Recreation, Sport	1%	0%	1%	1%	n/a	2%	1%	2%
Source: NLF (2017a)								

Income levels in the overall Eastern Newfoundland region are generally below the provincial average (Table 7.9). The exception is the Northeast Avalon (Economic Zone 19) where the economy provides a larger number of professional employment opportunities and median personal and family incomes are higher than that of the province (NLF 2017a).

Table 7.9 Personal and Family Income, Eastern Newfoundland (2013)

Economic Zone	Median Personal Income	Median Family Income
Zone 14: Gander-Fogo Island	$25,200	$46,900
Zone 15: Clarenville-Bonavista	$25,300	$46,000
Zone 16: Burin Peninsula	$25,600	$49,800
Zone 17: Conception Bay North-Bay de Verde	$25,700	$46,500
Zone 18: Whitbourne-St. Mary's	$29,000	$47,700

Economic Zone	Median Personal Income	Median Family Income
Zone 19: Northeast Avalon	$36,200	$60,400
Zone 20: Southern Shore-Trepassey	$30,600	$54,200
Province of Newfoundland and Labrador	$29,600	$52,000
Source: NLF (2017c)		

7.1.3 Regional Services and Infrastructure

Eastern Newfoundland municipalities generally offer a variety of services such as emergency planning, fire protection and response, land use planning and permitting, recreation, drinking water treatment and supply and wastewater collection/treatment. Recreation services are also provided by private operators.

7.1.3.1 Transportation

Eastern Newfoundland is connected by air, road and sea to other parts of the province and beyond. The NL Department of Transportation and Works provides highway construction and maintenance, publicly and privately operated ferry services and air services for forest fire protection and patient transport. The Trans Canada Highway Route 1 begins at St. John's and runs westward across Newfoundland with various provincial highways and secondary routes leading to communities. Regularly scheduled commercial air services are available at St. John's International Airport and Gander International Airport. Air landing strips are located at Bell Island, Harbour Grace, Clarenville and Winterland. Heliports are located at Conception Bay South, the Health Sciences Centre and St. John's International Airport and seaplane bases are found at Paddy's Pond and Thorburn Lake (DTW 2017). Eastern Newfoundland ferry services are described in Section 7.3 below. Marine Atlantic provides a seasonal ferry service to Nova Scotia and a private operator offers service to St. Pierre and Miquelon (a territory of France). Various other agencies provide public and private transportation options.

7.1.3.2 Utilities

In Newfoundland and Labrador, Newfoundland Power (NP) and Newfoundland & Labrador Hydro (Hydro) generate and distribute electricity to approximately 280,000 customers the majority of which are served by the Island interconnected system (NLH 2017; DNR 2017). Internet and cellular services are provided by various companies such as Bell, Rogers and Telus.

7.1.3.3 Waste Management

In Newfoundland and Labrador, solid waste and recycling collection services (e.g., waste and recycling collection, landfill disposal, safe management of hazardous waste, marketing of recycled materials) are provided by municipalities, groups of municipalities and/or regional service authorities. Most of the area referred to in this study is included in the Eastern Waste Management Region for which the Robin Hood Bay waste management site in St. John's serves as the regional facility. The Eastern Regional Services Board (ESRB) provides waste recovery facilities, curbside collection of solid waste and recycling, bulk waste collection and household hazardous waste collection events to a number of communities in the region (ERSB 2015). The portion of the region west of Clarenville is served by Central Newfoundland

Waste Management which provides waste and recycling collection throughout the region and waste and recycling management at its site in Norris Arm North.

7.1.3.4 Education

In Newfoundland and Labrador, Kindergarten to Grade 12 education is administered by the NL Department of Education and Early Childhood Development. The daily operations of public schools are administered by two school boards. The Newfoundland and Labrador English School District administers English schools through four regional offices including one in St. John's, which serves Eastern Newfoundland. The Conseil Scolaire Francophone administers the five French schools in the province. The Department also governs childcare and early childhood education and public libraries (EECD 2017).

The NL Department of Advanced Education, Skills and Labour (AESL) administers and supports post-secondary education and training in the province through Memorial University, the College of the North Atlantic (CNA) and private training institutions, through its Post-Secondary Education Branch. The Branch is also responsible for adult learning and literacy, financial assistance to post-secondary education students and apprenticeship and trades certification programs. The Department also provides employment and social services support programs including income support, supportive housing, career and employment services, student financing, services to immigrants and programs for the advancement of literacy, skills development and trades certification. In Eastern Newfoundland, the Department's Regional Service Delivery Branch operates Employment Centres in St. John's, Mount Pearl, Carbonear, Placentia, Clarenville and Marystown (AESL 2017). Memorial University, the only university in the province, provides degree programs through its main campus in St. John's and the Sir Wilfred Grenfell campus in Corner Brook. The CNA has campuses throughout the province including Gander, Carbonear, Clarenville, Placentia, St. John's and Seal Cove in Eastern Newfoundland (AESL 2017; CNA 2017).

7.1.3.5 Healthcare

The Eastern Regional Health Authority (Eastern Health) provides health and community services to approximately 300,000 people in 111 municipalities and 135 unincorporated communities throughout its service area, which encompasses the Avalon, Burin and Bonavista Peninsulas as far west as Port Blandford, Newfoundland. The agency delivers health services through a network of hospitals, community health centres, community clinics and long-term care facilities. These include 16 hospitals and health care centres that provide in-patient and/or out-patient services. In addition, a total of 83 clinics and health offices provide a variety of health promotion, physical health, mental health, community-based support and social services throughout the region. Patient ground transport is provided by public and private services and air ambulance is provided by the provincial government (Eastern Health 2014; 2016a).

The Eastern Health region encompasses 59 percent of the provincial population. Eastern Health also has a provincial mandate to provide provincial services in surgery, rehabilitation, oncology, cardiology, gynecology, pediatric, mental health and addictions, laboratory services and diagnostic imaging. The agency receives patients from the French islands of St. Pierre and Miquelon, through an external agreement (Eastern Health 2016a). Health care services and community supports are also delivered through private organizations, non-profit agencies and volunteer groups. The western portion of the

study area, beginning in the Terra Nova National Park area is served by Central Health. This agency provides a variety of diagnostic, treatment and community health services at health care facilities in Gander and Grand Falls-Windsor with community clinics and long-term care facilities located throughout the region.

7.1.3.6 Safety and Security Services

The Royal Newfoundland Constabulary (RNC), which is headquartered in St. John's provides service to a population of approximately 214,000 in 15 communities in Newfoundland and Labrador. In Eastern Newfoundland, the RNC serves the Northeast Avalon (RNC 2017). The Royal Canadian Mounted Police (RCMP) serves the remainder of Eastern Newfoundland through its East District which has 16 detachments (RCMP 2015). Fire prevention and response services are usually provided by municipalities to one or more communities.

7.1.4 Health and Well-Being

The most recent comprehensive information on health status in Eastern Newfoundland was provided by Eastern Health in 2016 and was compiled using a variety of internal health care system data and information as well as publicly available sources. The following summary gives a broad-based review of the reported health of the population of Eastern Newfoundland and the key health care issues faced by the region.

- It is anticipated that by 2035, approximately 28 percent of the population of the Eastern Health region will be over 65 years, which presents challenges for health care service delivery especially in rural areas.

- Social issues (e.g., poor education, low income and food insecurity) are known to have a strong impact on poor health and premature death. Regional residents have a higher unemployment rate than the national rate but lower than the provincial average. The region experienced an 8.9 percent decline in use of employment insurance between 2003 and 2013. The province and the Eastern Health region have had lower personal per capita income than the Canadian average. In 2011 and 2012, per capita income in the Eastern Health region exceeded that of Canada. In 2012, average couple family income surpassed the national average. In 2011-2012 households in this province had the lowest rate of food insecurity in the country. Though poverty stills exists in the province and the Eastern region, these factors should result in improved health outcomes.

- Poor prenatal and perinatal health care results in a high number of babies who may be at higher risk for poor health outcomes including childhood obesity. Newfoundland and Labrador has the lowest breastfeeding rates in the country but the rate is increasing in Eastern Newfoundland, especially in urban areas.

- Self-reported information on health behaviors such as smoking, drinking, inactivity and poor diet indicates that a high number of individuals are at high risk for disease (e.g., heart disease, diabetes, respiratory disease and cancers) and injury. In 2014, 93.4 percent of the Eastern region population reported having at least one of these risk factors and 44.3 percent had four risk factors. Smoking rates have decreased in the Eastern Health region, is higher

than the Canadian average but lower than the Newfoundland and Labrador average. Alcohol sales have increased in the province and the proportion of self-reported heavy drinkers (28.8 percent reported heavy drinking at least twice per month) in the Eastern region is higher than the national average (18.4 percent).

- Newfoundland and Labrador has a higher incidence of colorectal, cervical and breast cancer and screening is a valuable tool in addressing these cancers. In Eastern Newfoundland, cancer screening rates, especially for colorectal cancer, are below provincial targets.

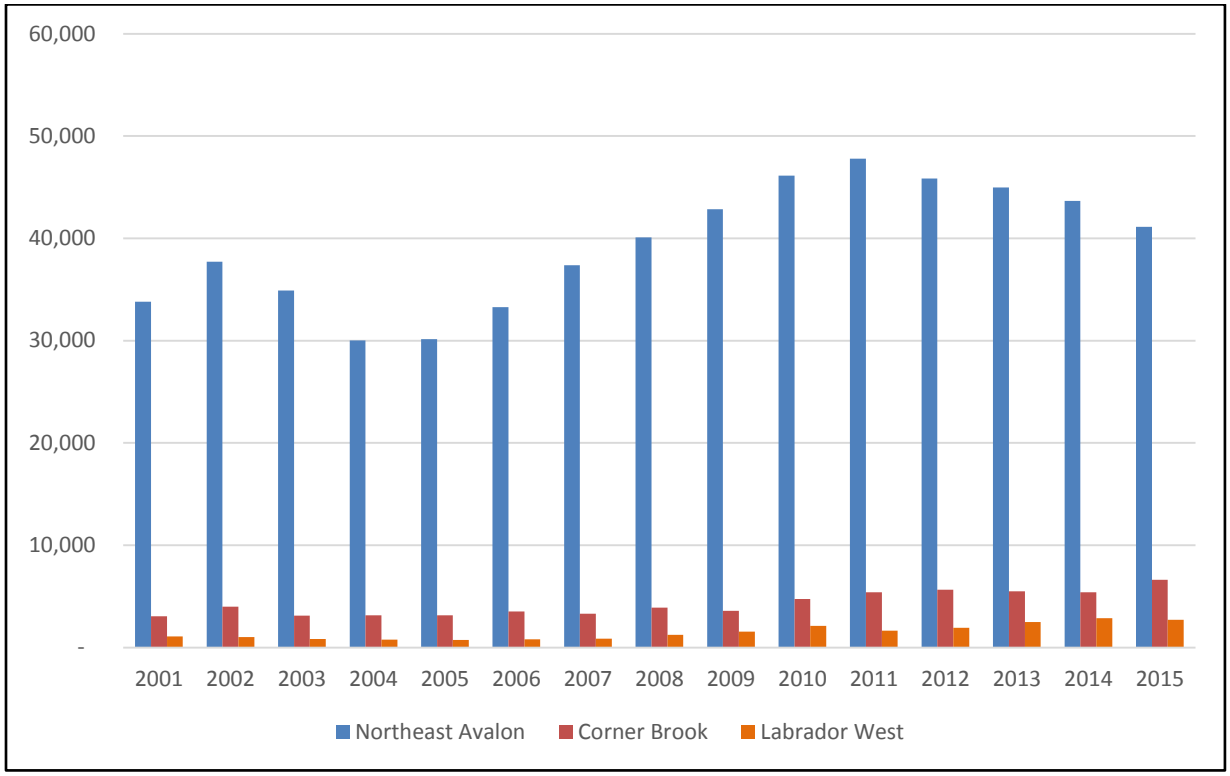
- Consumption of the daily recommended servings of fruit and vegetables in the Eastern Health region is below Canadian average and has declined. Residents of the region are also less physically active than the Canadian average.

- Nearly 74 percent of residents of the Eastern Health region report very good or excellent mental health and 93 percent reported being satisfied or very satisfied with life. The suicide rate for the region was lower than the Canadian rate. Males are more often hospitalized for mental health than females. In 2014/2015, rates of hospitalization for self-harm in the Eastern Health region were higher than the Canadian average but lower than the Provincial average. High rates of hospitalization for self-injury may indicate a failure to diagnose and treat mental health and distress in early stages (Eastern Health 2016b).

Types and rates of criminal activity can also be indicators of social issues and change, and changes in the type and level of crime may possibly be precipitated by changes in population and/or disposable income. Detailed information is not publicly available for communities policed by the RCMP but the RNC provides data on a variety of factors for its jurisdictions. Police reported incidents have generally increased in each of the areas served by the RNC since 2005 and have declined overall since 2011 (Figure 7.3). The number of police reported incidents are highest on the Northeast Avalon due to the population and large coverage area. Per capita police reported incidents on the Northeast Avalon in 2015 ((21:100) were slightly lower than the average (22:100) of all jurisdictions policed by the RNC (RNC 2017).

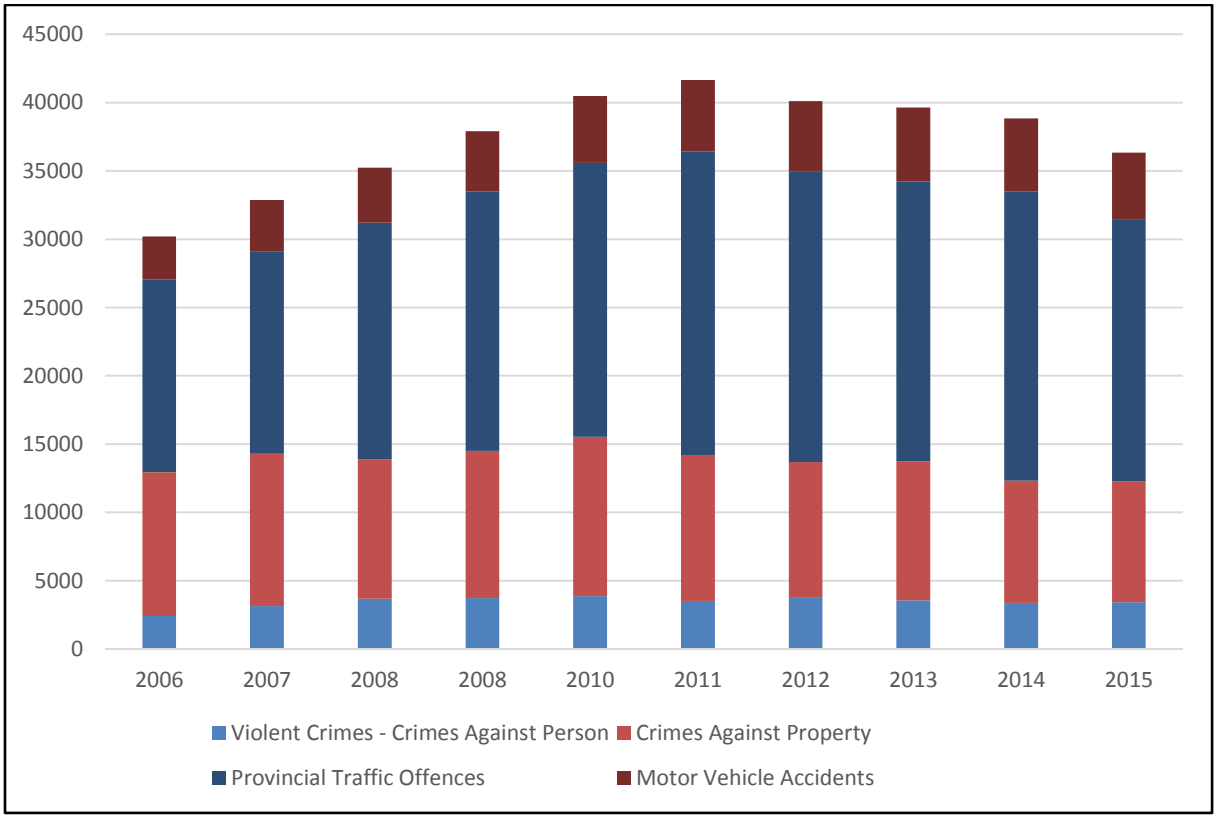
The number of police reported incidents on the Northeast Avalon increased annually between 2006 and 2011 (Figure 7.4). The total number of reported incidents has declined steadily since 2011 but was still higher in 2015 that in it was from 2006 to 2008. Most of these incidents are related to provincial traffic offenses followed by crimes against property, motor vehicle accidents and violent crimes (e.g., crimes against person such as murder, assault, sexual assault, abduction and extortion).

Figure 7.3 Police Reported Incidents in RNC Jurisdictions



Source: RNC (2017)

Figure 7.4 Select Police Reported Incidents on the Northeast Avalon



Source: RNC (2017)

7.2 Marine Fisheries

Marine fisheries operating within and around the Project Area and elsewhere off Newfoundland and Labrador are important in terms of levels of activity, employment and overall economic value. These offshore fisheries are also important socially, and are linked integrally to the region's industrial and cultural history dating back many centuries. While specific numbers are not available for the fishing enterprises or fishers who are dependent in some way on Project Area resources, province-wide in Newfoundland and Labrador the sector employed some 9,300 fishers and an additional 7,700 workers in the on-shore processing sector in 2015 (GNL 2016). In addition, commercial harvesters from other Atlantic Provinces may be operating in the Project Area at some time during the year. Beyond the EEZ, fishing enterprises from several other nations currently – and historically – share the waters with Canadian vessels on and near the margins and slopes of the Grand Banks (particularly the "Nose" and "Tail") and the Flemish Cap (Figure 7.5).

This section describes the historical and existing commercial fisheries within the Project Area (Figure 7.6) and adjacent waters and within the RSA (which is shown on all fisheries mapping in this section). These include the Canadian domestic fisheries, primarily on or adjacent to the continental shelf and slope, and non-Canadian fisheries outside Canada's 200-nautical-mile EEZ. In addition to these wild/capture fisheries, the section identifies fisheries science surveys that might occur in the general area, commercial aquaculture operations which are based in coastal settings to the west, as well as any Indigenous fisheries in the region, and the potential for recreational fishing activity.

7.2.1 Management Regimes and Administrative Boundaries

The Eastern Newfoundland Grand Banks and adjacent waters overlap with two principal fisheries management zones. Canada (through the DFO) has management and regulatory responsibility for fish stocks and fishing activity within most of its EEZ and for certain "sedentary species" - mainly snow crab (also known as queen crab), lobster and clams - over the entire Canadian continental shelf. By international convention, NAFO participates in the management of some species in part of the Canadian EEZ which is within its designated Convention Area and regulates most fisheries in the portion defined as the NAFO Regulatory Area (NRA). The NRA is specifically "that part of the Convention Area which lies beyond the areas in which Coastal States exercise fisheries jurisdiction" (i.e. outside of any state's EEZ, see Figure 7.5) (NAFO 2004).

As Figures 7.5 and 7.6 indicate, the Convention Area is further subdivided, for administrative and management purposes, into various Sub-Areas, Divisions and Unit Areas (UAs). DFO also utilizes these areas in its data reporting, management and regulatory regimes (e.g. licence conditions), and most of the fisheries descriptions that follow reference them. The UAs and Divisions are also used in the fisheries data analysis for this EIS.

7.2.2 Key Information Sources

This section uses information from several different sources, most published by DFO, NAFO and related agencies (such as the Canadian Science Advisory Secretariat), including fisheries management plans, science advisory reports, quota reports and other documents referenced in the text, as well as personal communications from key informants. Information about aquaculture is based on Newfoundland and Labrador Department of Fisheries and Land Resources sources. Other important sources are various

sets of statistical data which report catch quantities, values and location (at varying degrees of geographical resolution), by species, gear type, month and/or year.

For the commercial harvesting data presented in the following sections, four different datasets are used, each with a differing degree of resolution and statistical completeness. The historical (1985-2009) domestic fisheries harvesting graphs and tables in Section 7.2.3 are based on datasets provided by DFO before 2010. These datasets are quite complete and allow accurate reporting of harvesting quantities, times, locations and other information for each species landed in a Canadian port (DFO 1985-2009) . The most recently available domestic quantity and value data provided by DFO (for 2010-2015), used for the description of recent/current fisheries (Section 7.2.4) and as the basis for the associated graphs and tables, contain similar information but are less complete owing to redaction of some quantity and value data to meet more recent confidentiality requirements, particularly in the latest years reported. Overall, these more recent data provided by DFO (in January 2017) are estimated to suppress approximately 15 to 20 percent of the actual total quantity and value of the harvest (DFO 2010-2015a). For this quantity and value dataset, the finest level of geographic resolution is the UA. Consequently, for all the domestic fisheries descriptions presented below, UA-level data are presented. A further DFO dataset is used for the maps depicting harvesting locations. This was provided by DFO as an aggregated set which gives a general indication of catch locations (by year, month, species, gear types and other categories) but with no quantities or values attached, for a series of “cells” that are approximately 6 x 4 nautical miles in size (DFO 2010-2015b). Each of these datasets record both domestic and foreign fish harvests landed in Canada. The 2015 fisheries data remain the most current available from DFO as of the time of EIS writing and submission (J. Hosein, DFO, pers. comm.).

Multinational fisheries data (Section 7.2.9) are derived from NAFO statistical datasets, but these are only accessible at the much larger NAFO Division level, so that the information is much less geographically resolved than the Unit-Area-level analysis for domestic landings in this EIS. These divisional data (quantities only) are based on NAFO’s STATLANT 21 database which allow organization and/or aggregation by division, signatory nation, species and year (NAFO 2017a). Mapping of areas of multinational fishing effort is also derived from NAFO-provided data, as cited in the descriptions.

In the following baseline descriptions of the domestic commercial fisheries, three geographical areas are considered. The first is used for the Project Area (see Figure 7.6) analysis: it includes all landings data for UAs 3Li and 3Ma, the two NAFO UAs that overlap the Project Area (although the Project Area itself makes up just 8.5 percent of the total geographical area of these two UAs). The second geographical area provides a broader context for the fisheries in the general area of planned Project activities, the harvesting with in the five UAs that surround the Project Area - the “Adjacent UAs”. These include the two Project Area UAs plus UAs 3Le, 3Lt and 3Mc, as shown in Figure 7.6. The third geographical area is the RSA defined in Sections 4.3.1 and 13.1, which includes NAFO Divisions 3KLMNO.

For the description of the international fisheries, all NAFO data for Divisions 3L and 3M are utilized to characterize the Project Area fisheries since it overlaps some part of both Divisions, although it should be noted that the Project Area occupies less than two percent of the total geographical area of these two NAFO Divisions. For the RSA, NAFO data for Divisions 3KLMNO are used. All quantities in these sections are given in metric tonnes, and values are in current-year (unadjusted) Canadian dollars.

Figure 7.5 NAFO Convention Area, NRA and Divisions

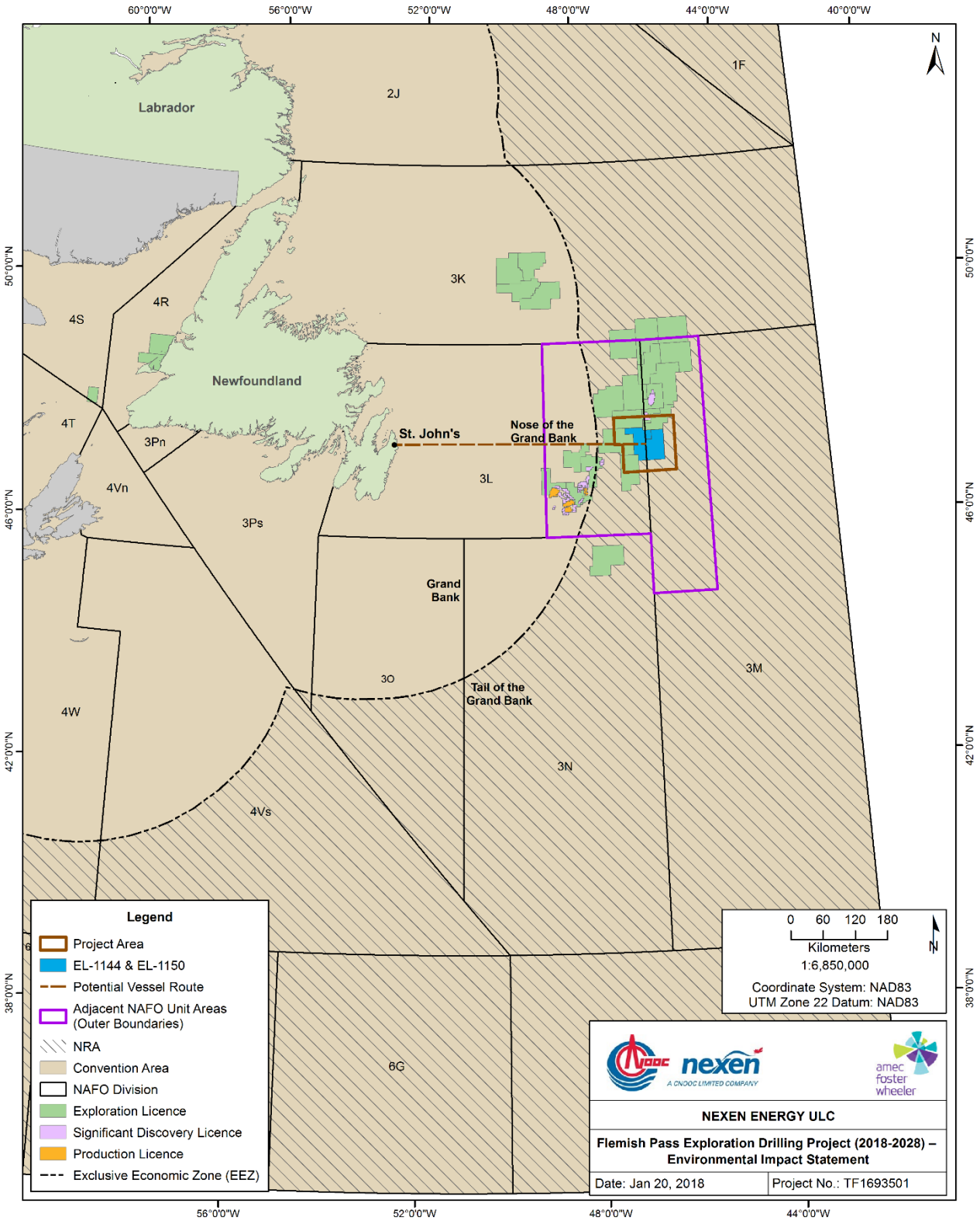
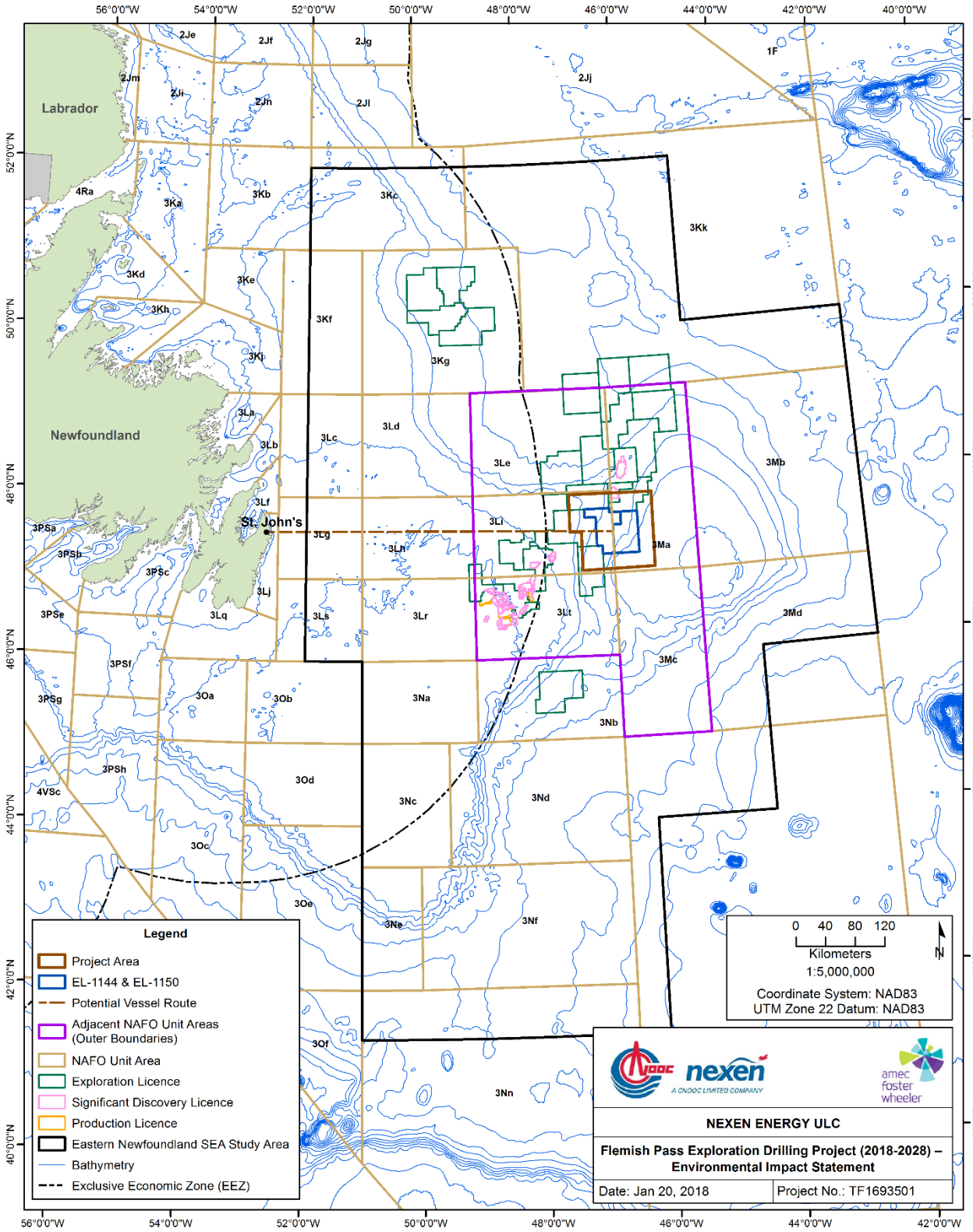


Figure 7.6 NAFO Unit Areas



7.2.3 Overview of Past Commercial (Domestic) Fisheries

The following provides a summary of historical fisheries within the Project Area UAs and the Adjacent UAs for the 25-year period 1985 to 2009. This is important for understanding the substantial changes in harvesting that occurred in the Atlantic Canadian fisheries during this period. The history is particularly relevant to the present EIS since, if groundfish (demersal) stocks improve sufficiently, fisheries more like the historic species mix and levels of effort might occur in or near the Project Area within the temporal scope of this EIS.

Figures 7.7 to 7.8 indicate the overall decline in harvesting that began in the early 1990s owing to declining stocks and, in 1992, the imposition by DFO of a moratorium on the harvesting of Atlantic cod and several other groundfish species. As the data show, the fisheries in most parts of the Project Area UAs were dominated by groundfish harvesting until the early 1990s. This was primarily Atlantic cod but included American plaice and a number of other species. In 1992, with increasing evidence that several stocks had reached an unsustainably low level, a fishing moratorium was declared and directed fisheries for cod were halted. After the moratorium was instituted, with increased fishing effort, new markets and increasing shellfish populations – mainly northern shrimp and snow crab – came to replace traditional groundfish species in the Project Area, as they have in many other parts of Atlantic Canada (Figures 7.10 to 7.13). Consequently, the fisheries “mix” in the area changed from almost exclusively groundfish to predominantly shellfish after 1992. This is reflected in the catch composition presented in Figures 7.10 to 7.13 for 1985 compared to 2009. With the exception of the eastern Grand Banks - Flemish Cap northern shrimp fishery, which is now under closure, Figure 7.13 represents harvesting that is more typical of the current situation.

Although groundfish quantities declined, as did the number of fish harvesters in the province, the landed value of the overall catch in Newfoundland and Labrador has remained relatively steady, or increased in some cases, owing to the higher-value species pursued after 1992. For example, the landed value of snow crab in Newfoundland and Labrador increased from under $13 million in 1992 to nearly $180 million in 2008 (DFO 2010a). Similarly, the landed value of northern shrimp increased from approximately $230 million in 1997 to $350 million in 2005 (DFO 2010b). These trends are described further in the overview of historic fisheries and associated catch statistics presented in recent SEAs and EAs that cover the Project Area (eg, Amec 2014).

Note that in the following historic fisheries graphs, only quantities of catch are presented as these are more directly comparable than economic values (particularly over many years) since the latter data reflect several factors other than resource availability or fishing effort. Value differences often occur from year to year simply because of price fluctuations determined by a variety of external market factors, including international exchange rates, demand and market competition, especially over a 25-year timeframe.

Figure 7.7 All Species: Project Area UAs and Adjacent UAs, Quantity of Harvest by Year, 1985-2009

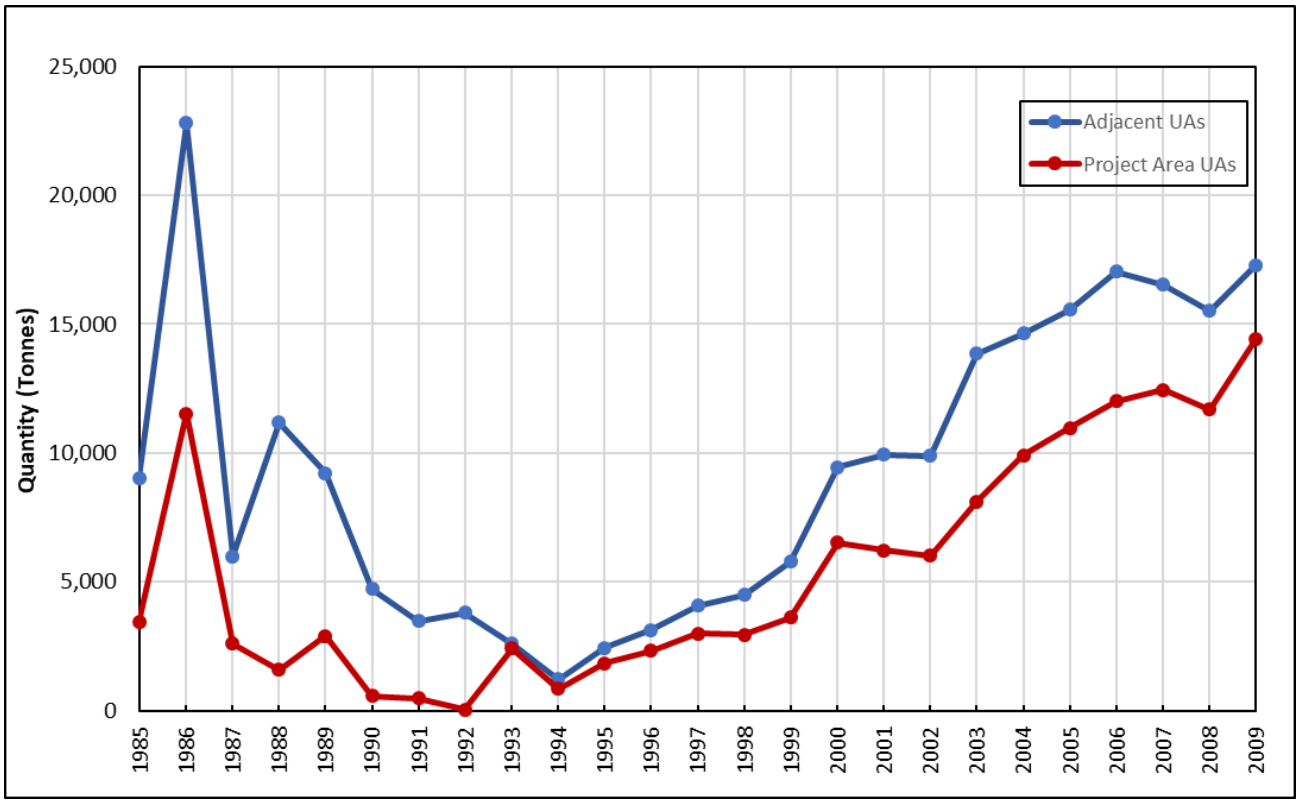


Figure 7.8 Groundfish vs Other Species: Project Area UAs Quantity of Harvest by Year, 1985-2009

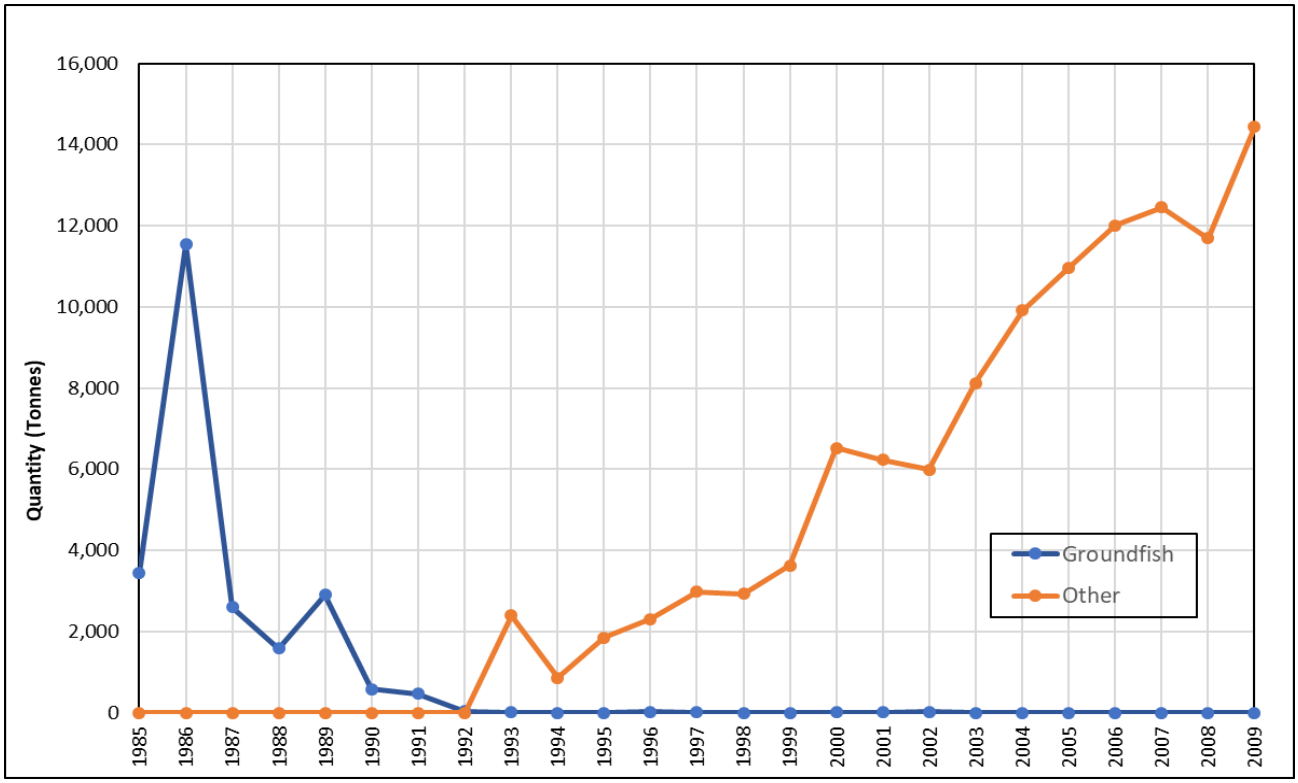


Figure 7.9 Groundfish vs Other Species, Adjacent UAs Quantity of Harvest by Year, 1985-2009

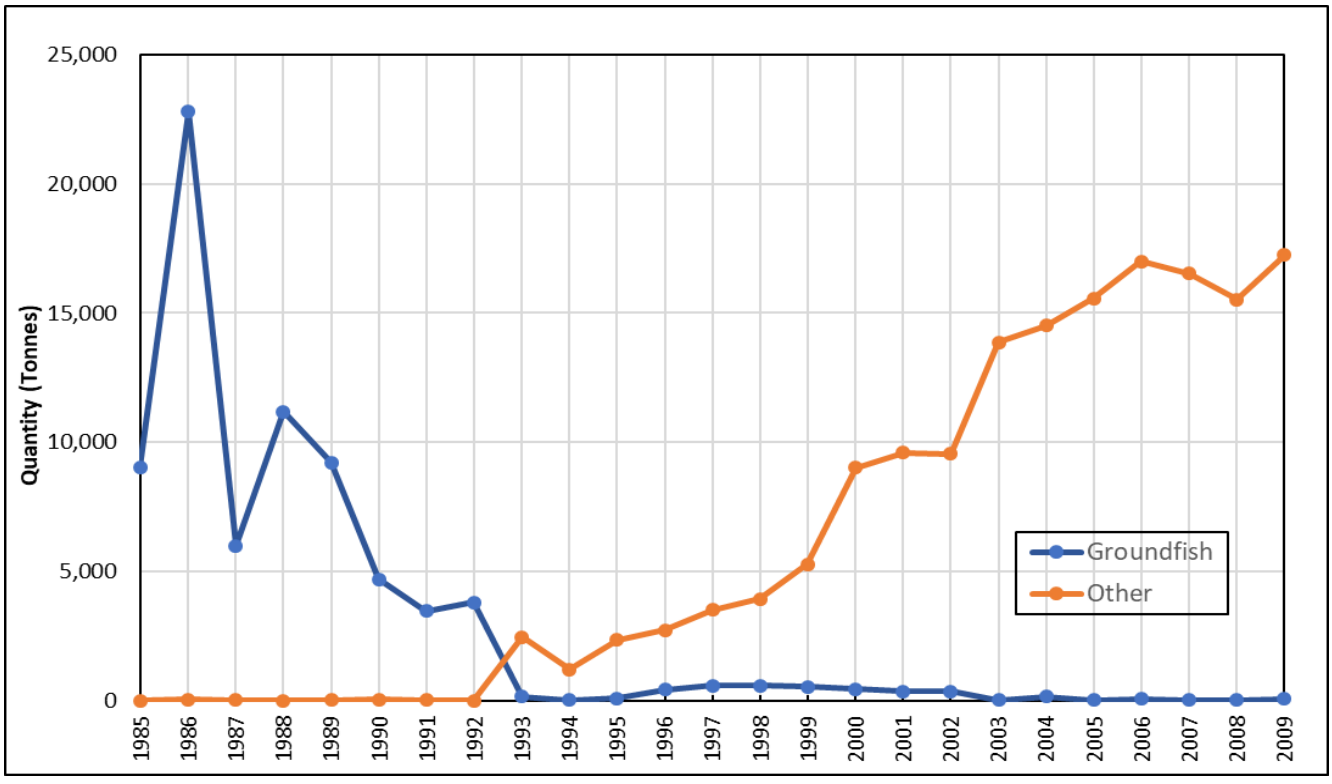


Figure 7.10 Species Composition by Quantity of Harvest, Project Area UAs 1985

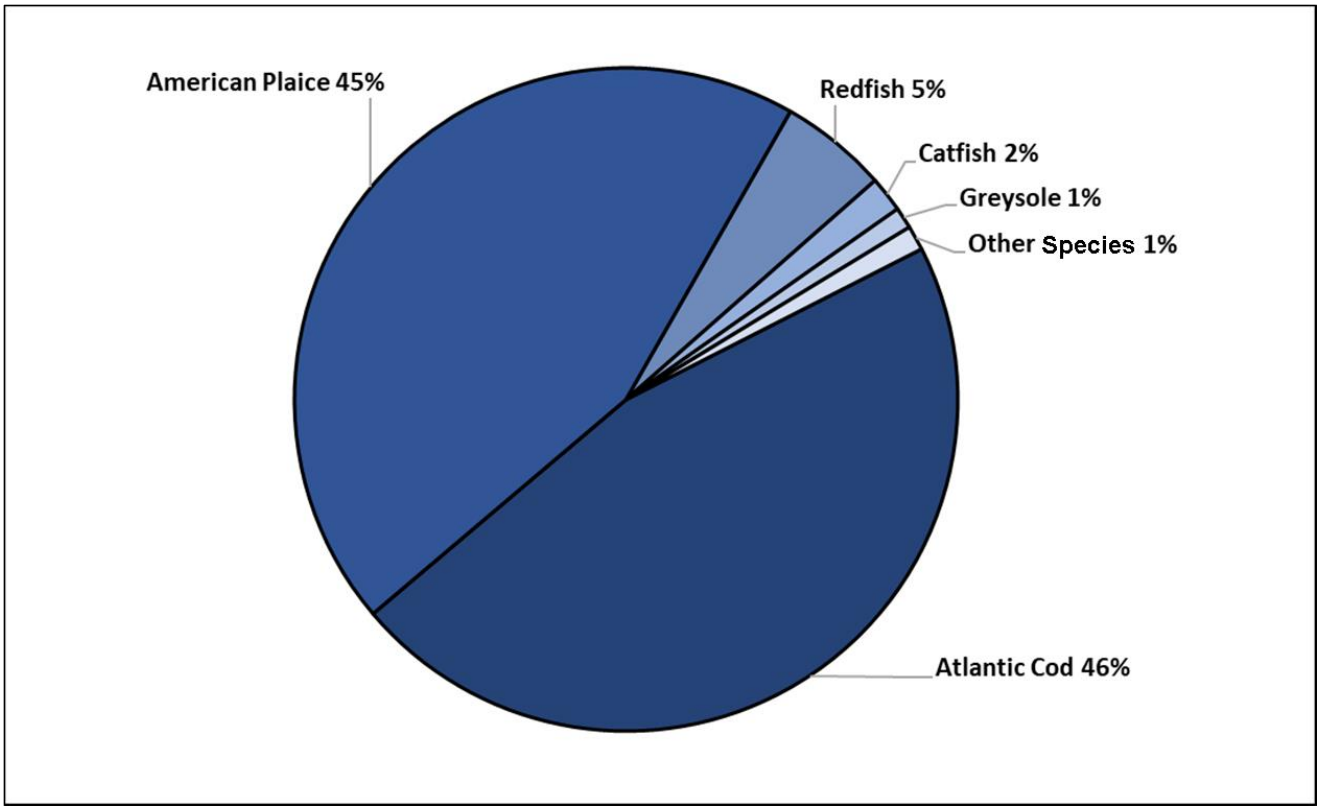


Figure 7.11 Species Composition by Quantity of Harvest, Project Area UAs 2009

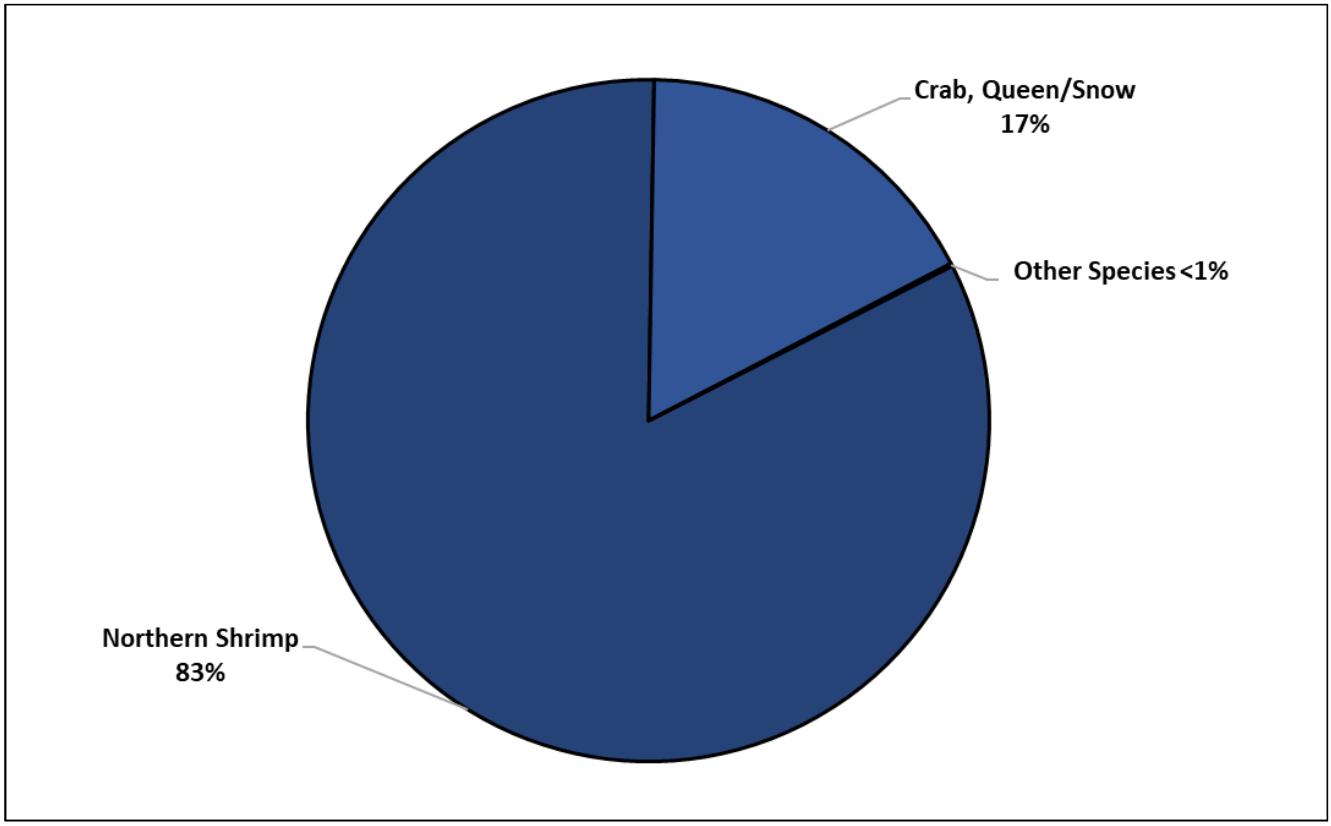


Figure 7.12 Species Composition of Harvest by Quantity, Adjacent UAs 1985

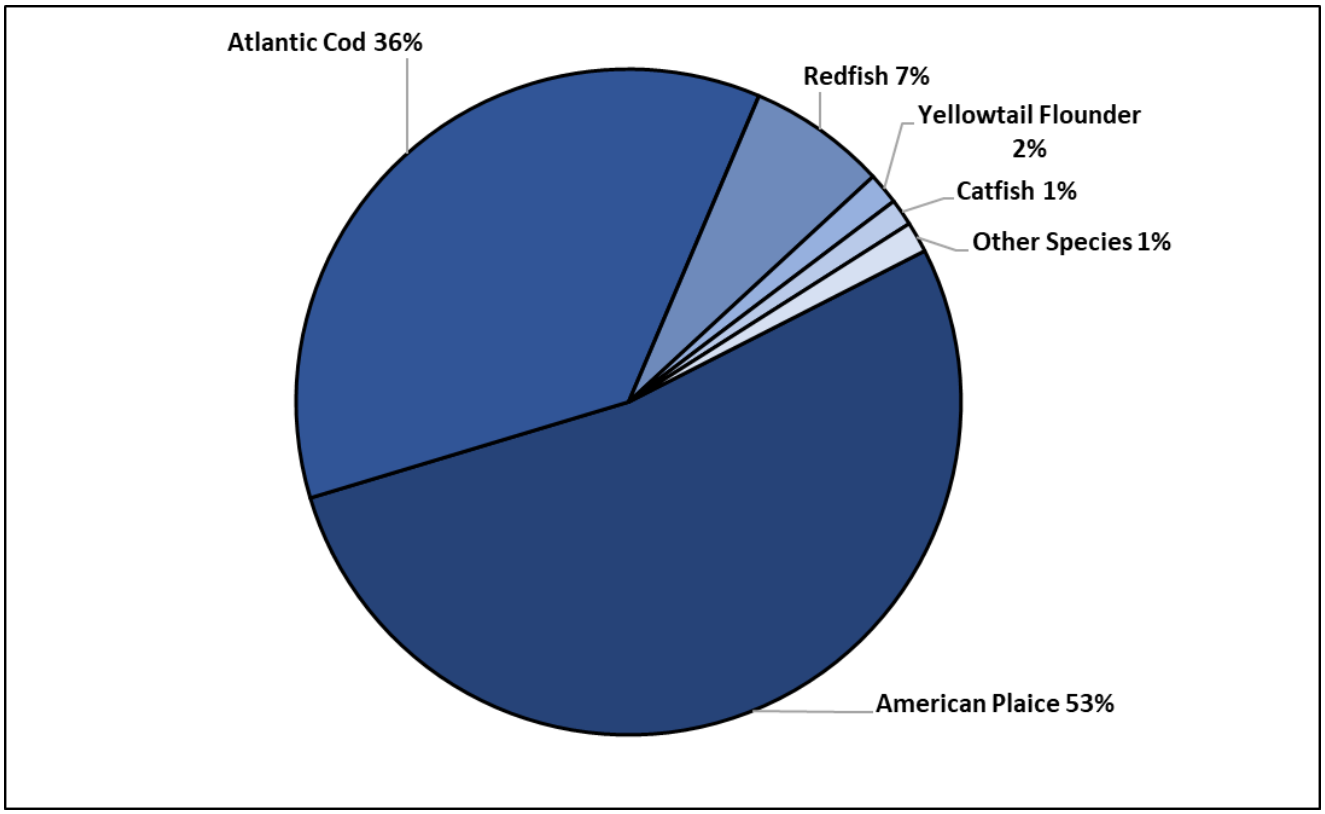
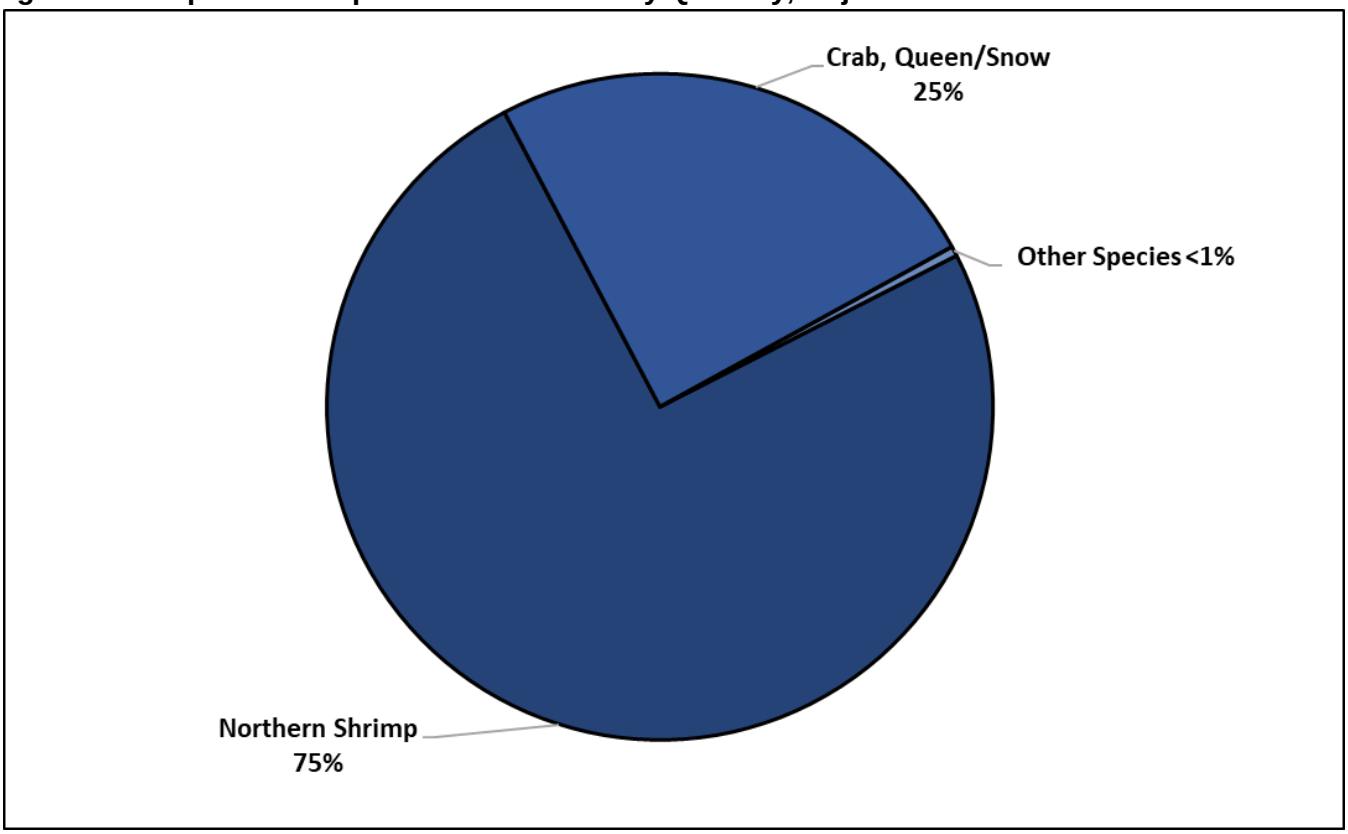


Figure 7.13 Species Composition of Harvest by Quantity, Adjacent UAs 2009



7.2.4 Current Commercial (Domestic) Fisheries

This section provides an overview of recent domestic fisheries (mainly since 2010) including the composition of the harvest by species, recent changes in catch, locations of fishing activity, fishing gear and gear distribution, and overall harvesting seasonality. Following sub-sections then present a more detailed focus on the key species fisheries identified.

7.2.4.1 Harvest Composition and Values

The species mix in the Project Area and Adjacent UAs in recent years has been predominantly shellfish (Northern shrimp and snow crab), which is illustrated in Figures 7.14 and 7.15. Table 7.10 provides recorded catch quantities and values for recent Project Area UAs and Adjacent Area UAs fisheries, based on the 2010 to 2015 average harvests and the latest available data from DFO, for 2015. As discussed above (Section 7.2.2) data for the most recent years - especially 2014 and 2015 - has been substantially redacted by DFO for confidentiality reasons and therefore the data received are not able to quantify accurately several of the important fisheries. For example, while the single year 2015 data in Table 7.10 and the composition of the Project Area UA harvests would seem to suggest that by 2015 the groundfisheries had all but ended, this is not the case. Therefore, in the following domestic commercial fisheries sections, the data presenting 2010 – 2015 averages should be considered as more representative of the current situation since the period includes several years when the data were much less redacted. The fishery for Northern shrimp has recently been halted in the Project Area and Adjacent UAs, as discussed in Section 7.2.4.5.

Table 7.10 All Fish Species by Quantity and Value, 2010-2015 Average and 2015

Species	2010-15 Average Quantity (tonnes)	2010-15 Average Value ($)	2015 Quantity (tonnes)	2015 Value ($)
Project Area UAs				
Queen/Snow Crab	3,077.5	13,767,781	3,367.2	18,335,834
Northern Shrimp	3,668.3	6,450,571	0	0
Turbot/Greenland Halibut*	3.3	20,071	0	0
Redfish*	1.5	1,432	0	0
Atlantic Herring	1.3	354	0	0
Atlantic Cod*	0.5	612	0	0
All Other Species	0.6	1,942	0	0
Totals	6,753.0	20,242,763	3,367.2	18,335,834
Adjacent UAs				
Queen/Snow Crab	5,150.0	23,121,127	5,375.3	29,270,714
Northern Shrimp	3,927.4	6,980,940	0	0
Redfish*	277.2	425,784	0	0
Turbot/Greenland Halibut*	112.4	395,061	0	0
Atlantic Cod*	32.6	37,780	0	0
Atlantic Herring	16.3	4,751	0	0
Groundfish Heads*	10.2	40,589	0	0
Atlantic Halibut*	4.5	36,296	0	0
American Plaice*	2.6	2,006	0	0

Species	2010-15 Average Quantity (tonnes)	2010-15 Average Value ($)	2015 Quantity (tonnes)	2015 Value ($)
Greysole Flounder*	1.7	2,158	0	0
Capelin	1.4	244	0	0
All Other Species	0.7	748	0	0
Totals	9,536.8	31,047,484.17	5,375.3	29,270,714
* Classified by DFO as groundfish (demersal) species.				

Figure 7.14 Species Types by Quantity of Harvest, Project Area Unit Areas 2010-2015 Average

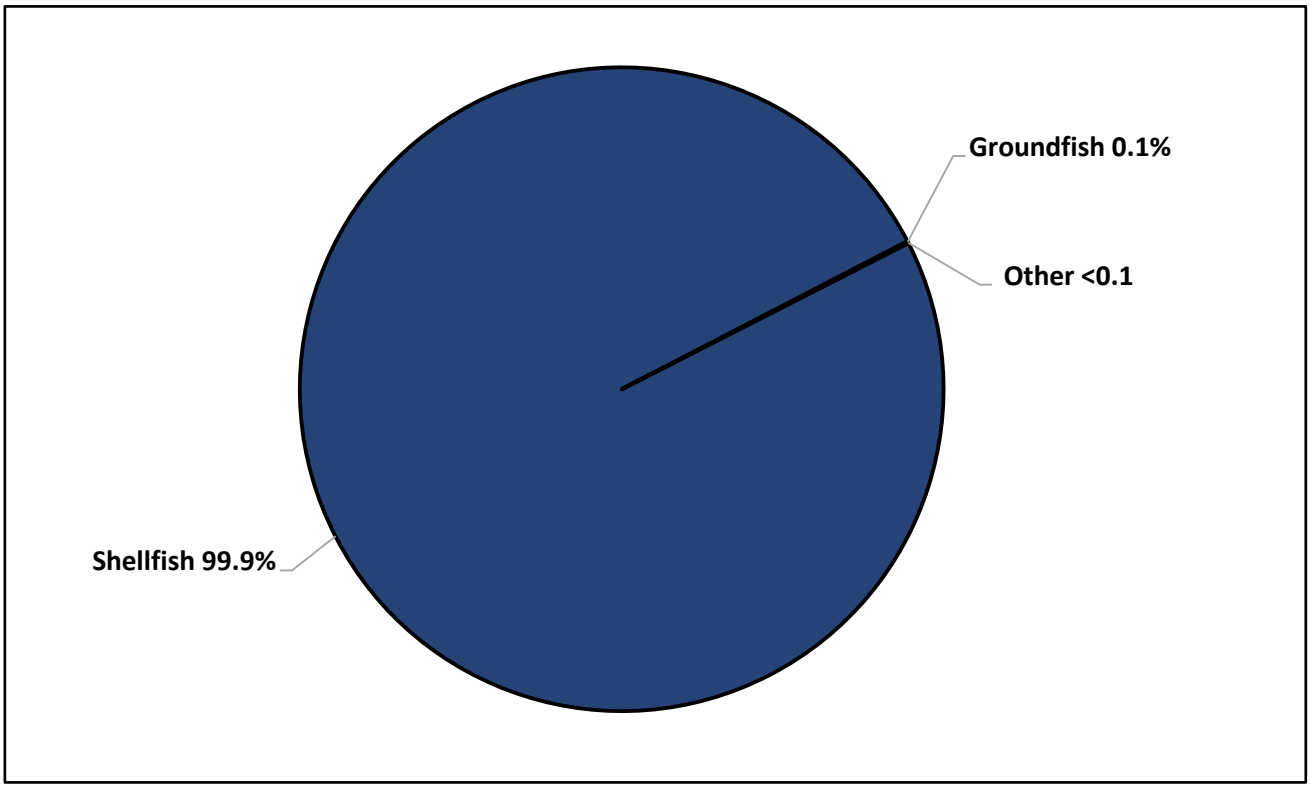


Figure 7.15 Species Types by Quantity of Harvest, Adjacent Unit Areas 2010-2015 Average

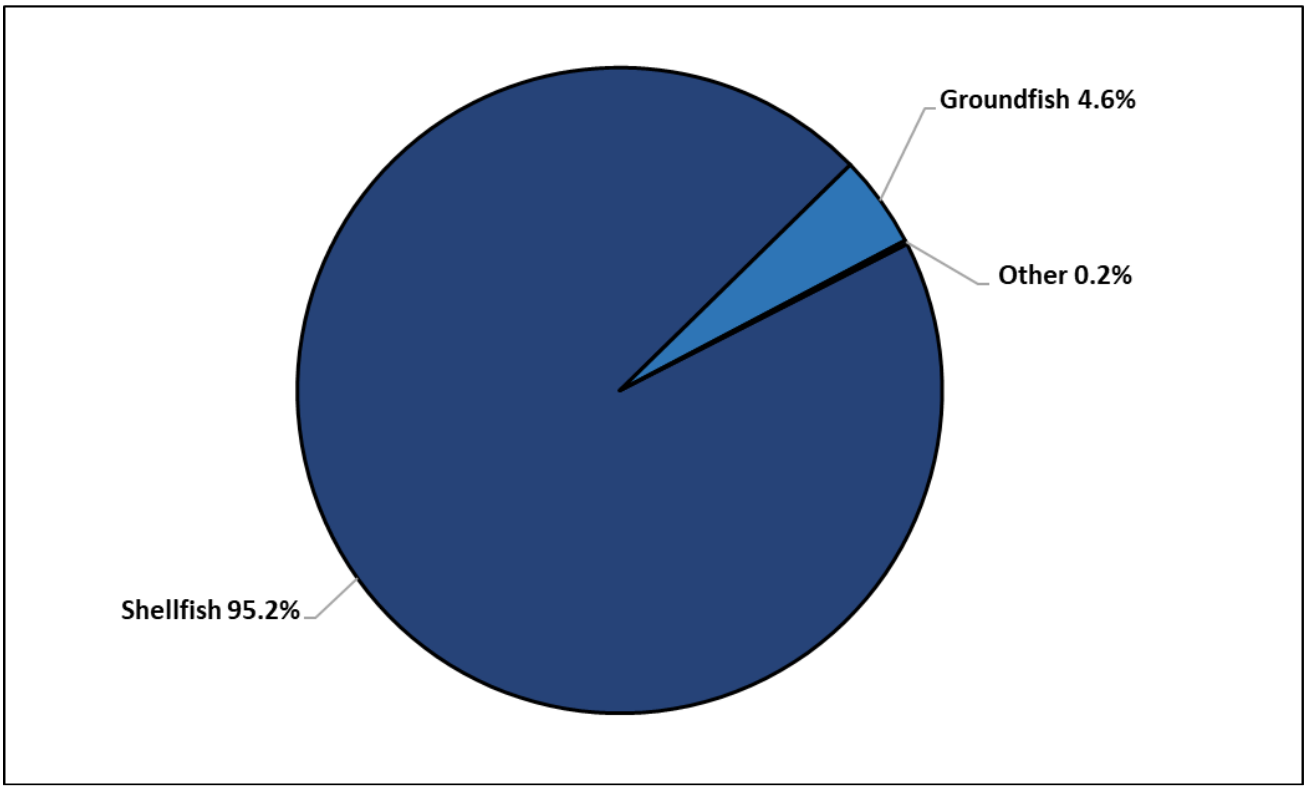


Table 7.11 quantifies the catch data (quantity and value) for available years from 2010 to 2015 – again noting that data for the most recent years (2014 and 2015) are most heavily redacted, so that the decline in quantities for several species suggested for those years may be misleading. The comparatively stable overall value of the harvest in those years – particularly with the loss of northern shrimp in these areas – is owing to increasing prices paid to fishing enterprises for some species, particularly for snow crab, where the landed price per kilogram nearly doubled between 2010 and 2015. Figures 7.16 and 7.17 show graphically the annual changes in harvest quantities and values reported in the data.

Table 7.11 All Fish Species Quantity and Value by Year, Project Area UAs and Adjacent UAs 2010-2015

Year	Project Area UAs		Adjacent UAs	
	Quantity (tonnes)	Value ($)	Quantity (tonnes)	Value ($)
2010	14,357	26,488,007	16,730	32,991,778
2011	10,167	27,220,119	13,843	39,846,420
2012	5,779	18,542,389	8,429	28,834,297
2013	3,644	15,257,890	7,261	27,906,947
2014	3,203	15,612,350	5,583	27,434,761
2015	3,367	18,335,834	5,375	29,270,714
Totals	40,518	121,456,589	57,221	186,284,917

Figure 7.16 All Species Quantity by Year, Project Area UAs and Adjacent UAs 2010-2015

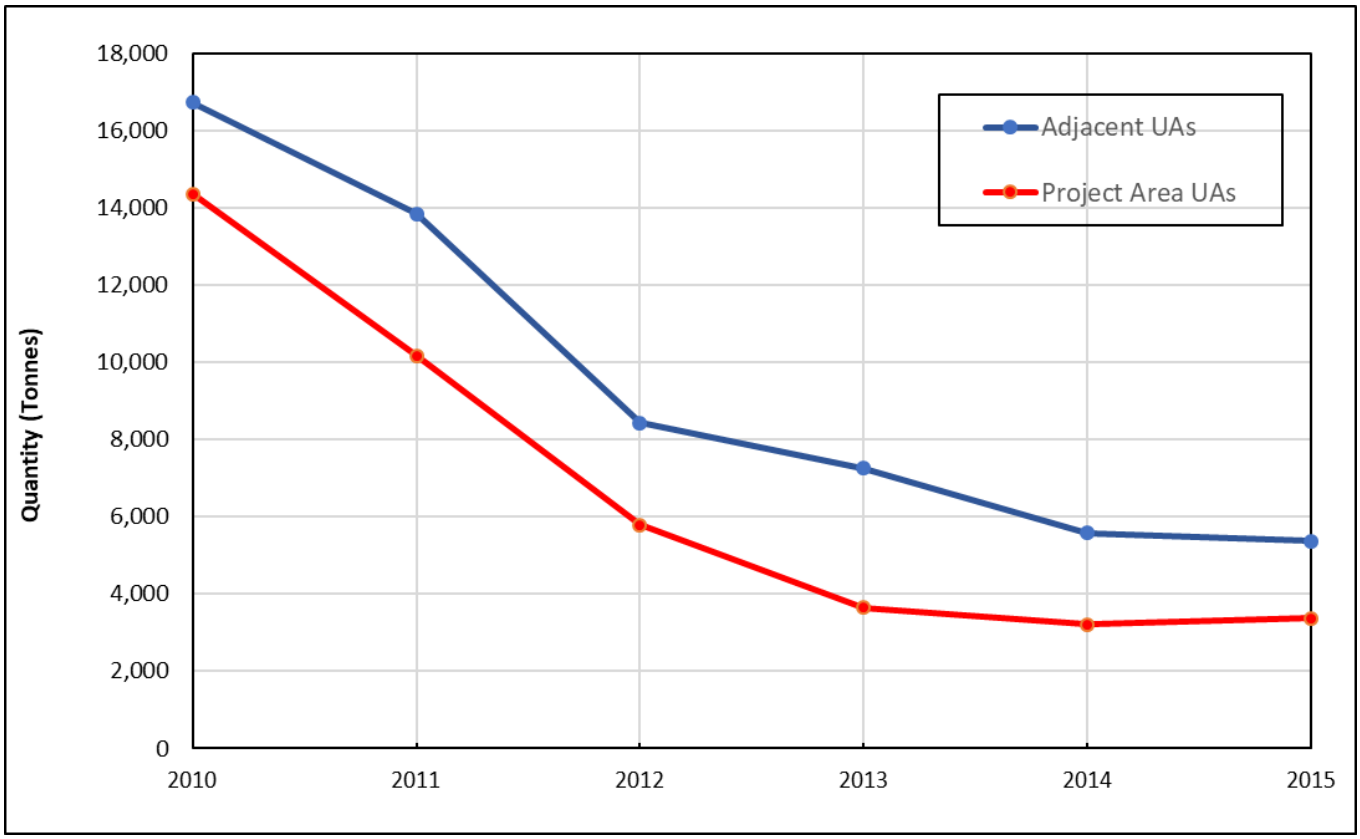
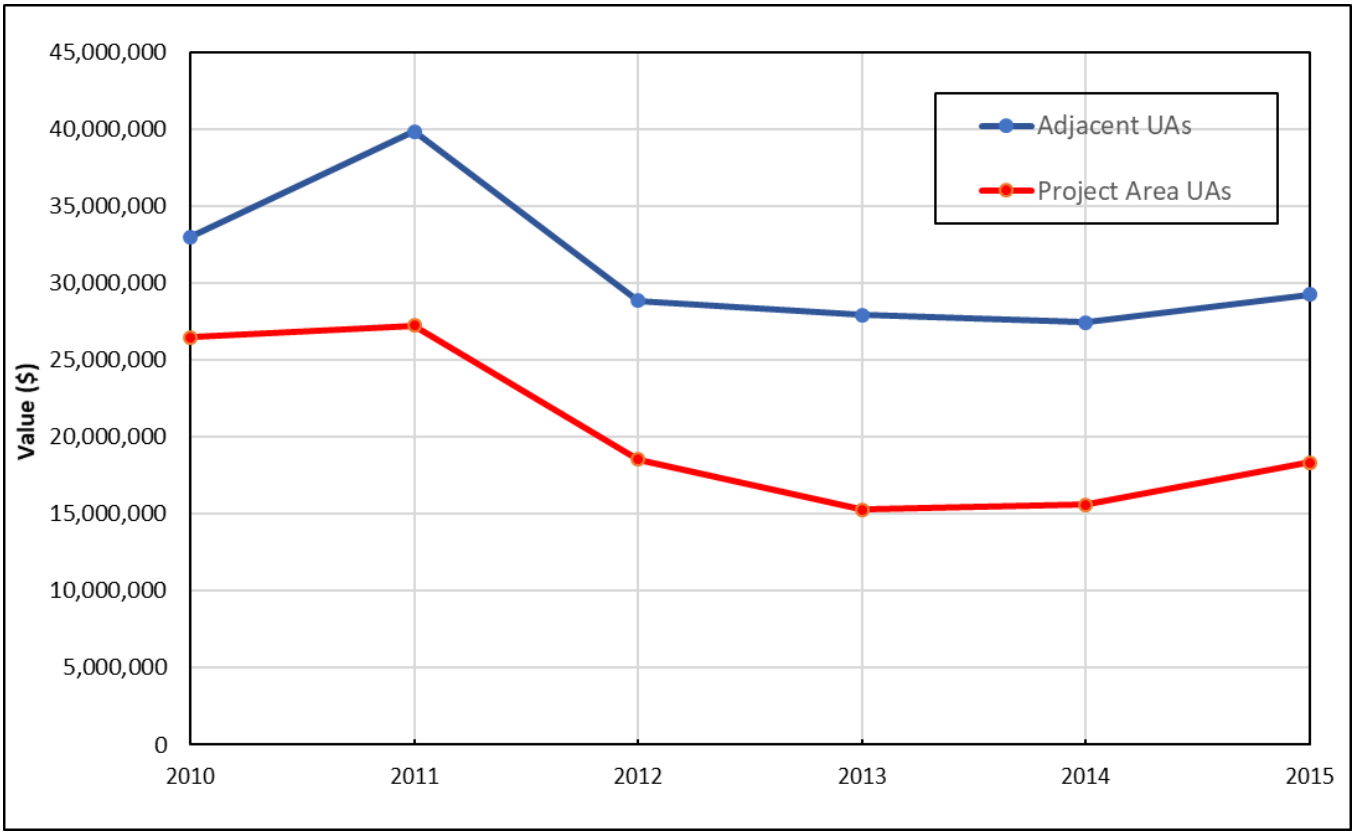


Figure 7.17 All Species Value by Year, Project Area UAs and Adjacent UAs 2010-2015



7.2.4.2 Harvesting Locations

Fish harvesting occurs where the targeted species is known or likely to occur, which in turn is primarily influenced by available habitat, including prey species. Consequently, the discussion and graphics for commercial species presented in this assessment are very relevant to an understanding of harvesting locations. Other factors affecting where fishing occurs are management regimes attached to licence conditions which specify for some fisheries where fishing is restricted, or closed to certain fleets.

Figures 7.18 and 7.19 indicate relative domestic harvest quantities and values by UA level for the five Adjacent UAs. As the data show, two of the included UAs (3Li and 3Lt) account for nearly 95 percent of the domestic catch quantity and value for the 2010-2015 period harvest. Of the two Project Area UAs, (indicated with an asterisk) only 3Li has a substantial proportion of the domestic harvest, and as the maps that follow also show, there is very little domestic harvesting within NAFO Division 3M.

Figure 7.18 Relative Quantity of Domestic Harvest by Unit Area, Adjacent Unit Areas 2010-2015

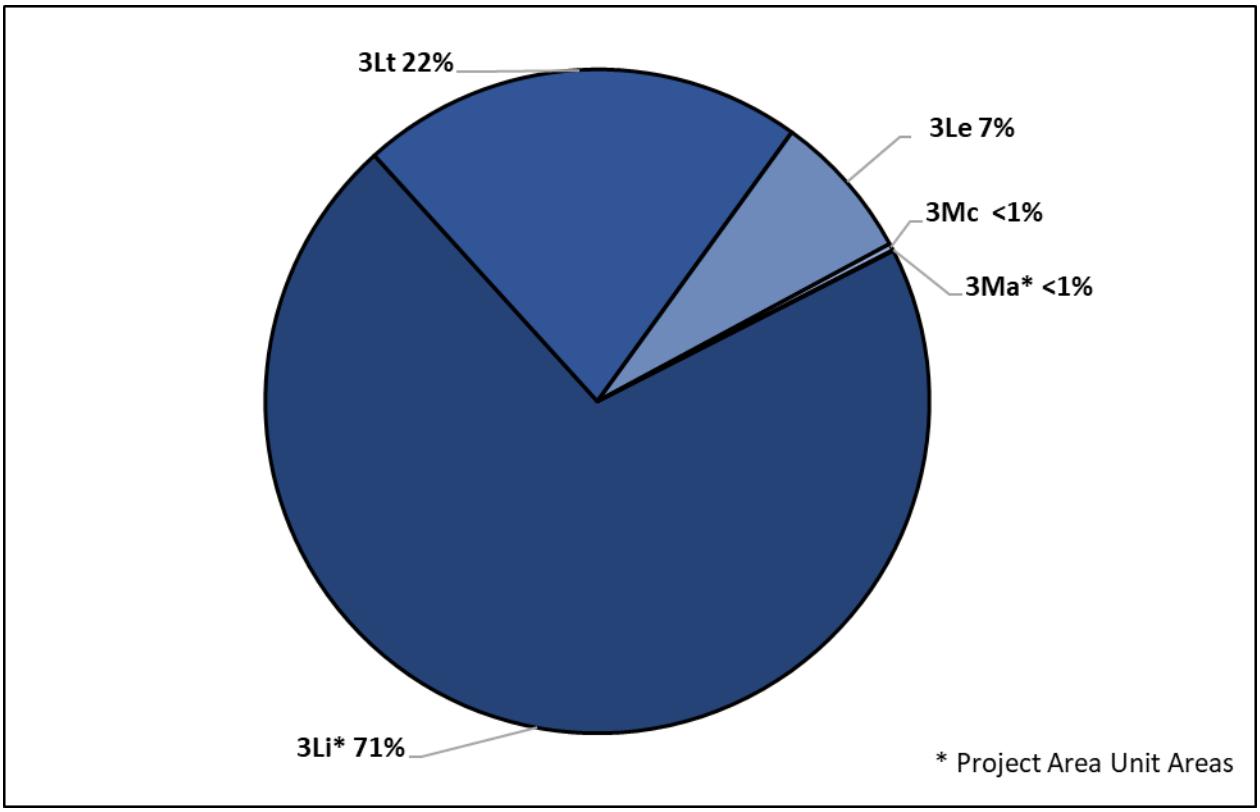


Figure 7.19 Relative Value of Domestic Harvest by Unit Area, Adjacent Unit Areas 2010-2015

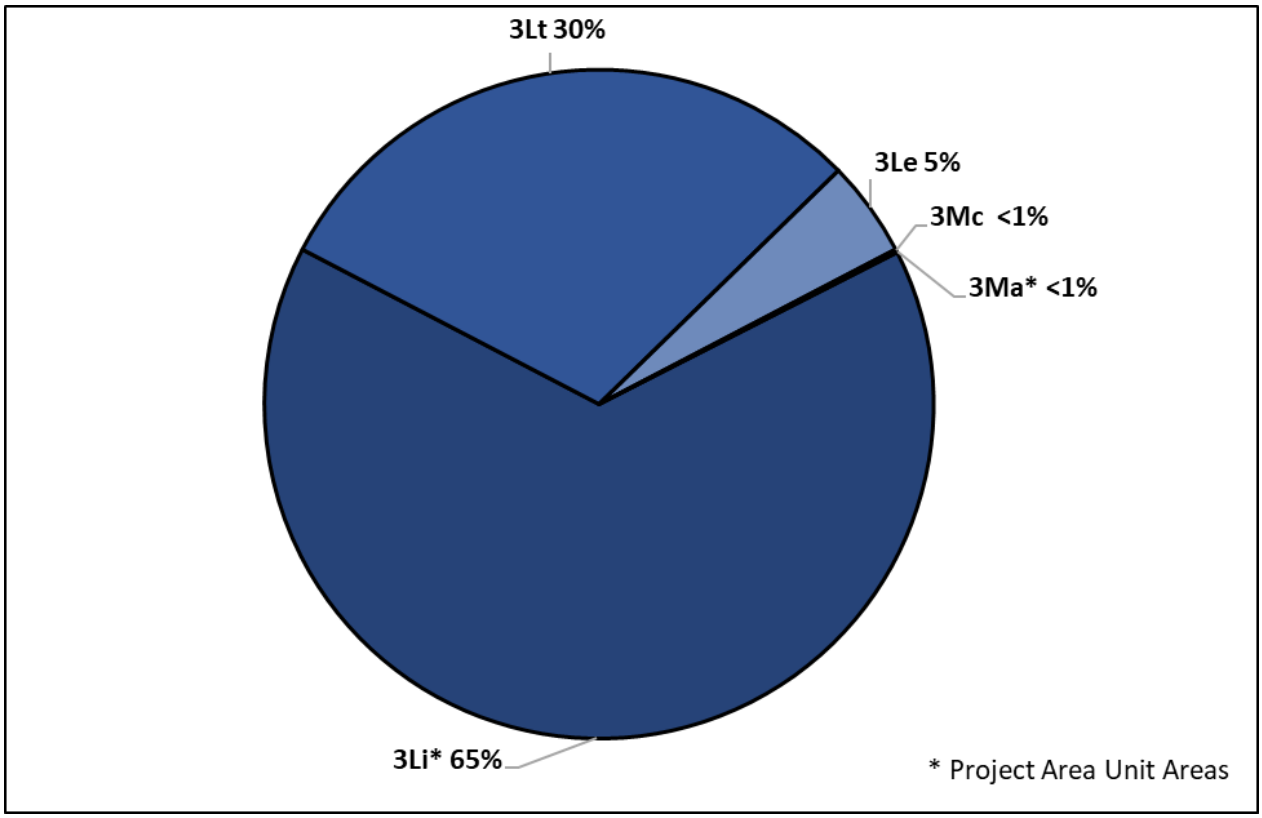


Figure 7.20 below shows the recorded geographic distribution of domestic commercial fishing activity within and adjacent to the Project Area and the Adjacent UAs. As indicated previously, the information provided in these maps is based on the geospatial data received from DFO. They show the general presence of recorded fishing activity for a series of 6 x 4 nautical mile “cells” that together comprise a map grid that covers the region.

The information presented here includes data for all years from 2010 to 2015, aggregated for all species, with more recent year colour overlying earlier years’ data locations for each “grid square”. Figure 7.21 uses the same data source but aggregates and colour-codes the number of records at each location, with a “hotter” colour indicating where more fishing activity reports occurred to give an indication of harvesting intensity.

As the maps indicate, comparatively little domestic harvesting has been recorded within the Project Area itself, and less within the EL boundaries, with most of the Project Area Unit Area catches (used in the preceding tables) occurring to the west in Unit Area 3Li. Further information on commercial fishing locations by gear type, month and season, and key species is provided in following sections.

Figure 7.20 Domestic Commercial Harvesting Locations, All Species, 2010-2015

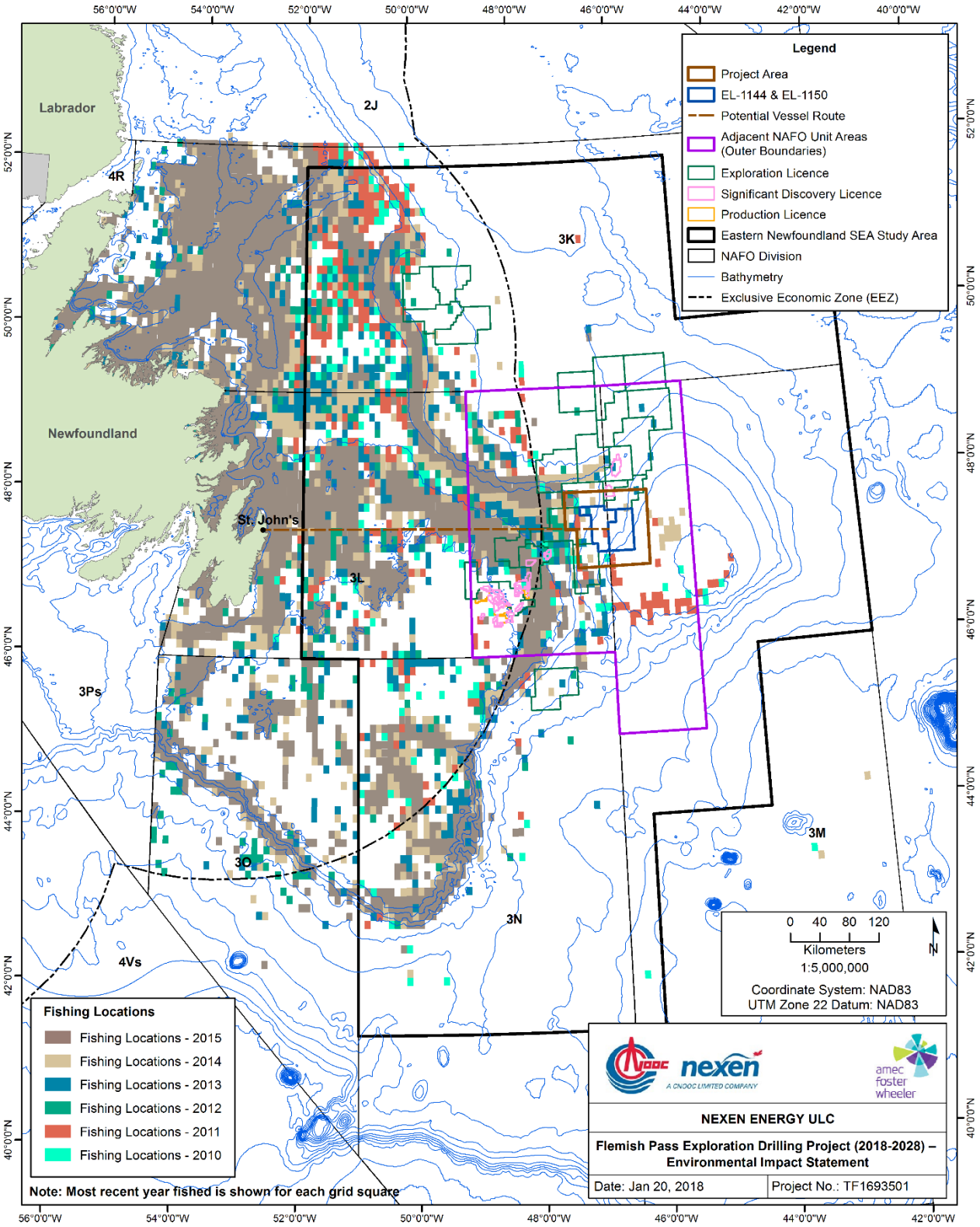
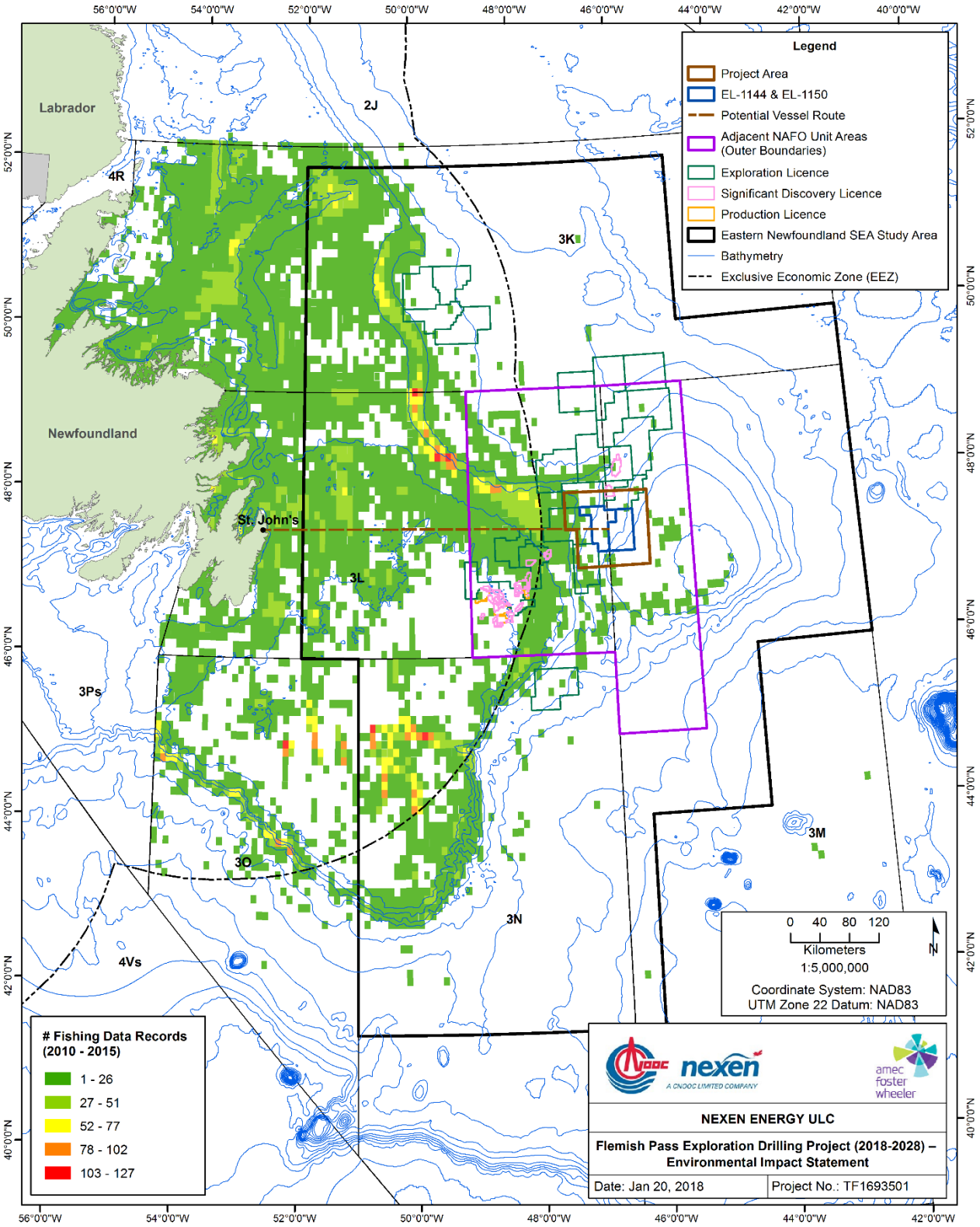


Figure 7.21 Domestic Commercial Harvesting Intensity by Locations, All Species, 2010-2015



7.2.4.3 Fishing Gear

Some of the fishing gears used in the Project Area and Adjacent UAs (and in Atlantic Canada generally) are designed to harvest particular species, while others are less selective and may be used to target, or to take as by-catch, many different species. Table 7.12 quantifies the average annual domestic harvest by gear and gear type (fixed or mobile) for 2010-2015; for 2015, the harvest reported in the dataset for both areas was 100 percent using crab pots, as this was the only species recorded. The change from the 2010-2015 average to 2015 is partly the result of the increasingly redacted harvest data, but also reflects the closure of the shrimp fishery in the area.

The two kinds of gear that accounted for the largest part of the catch by both quantity and value (pots and shrimp trawl) for the 2010-2015 period are used to target individual species in the Project Area - pots for snow crab and trawls for Northern shrimp, although both gear types occasionally record a small number of by-catch species. Other gears, most notably bottom (stern) otter trawls, catch a much wider variety of species, both directed and by-catch, including redfish, turbot (also known as Greenland halibut), and Atlantic cod.

Table 7.12 Harvest Quantity and Value by Fishing Gear Type, Project Area UAs and Adjacent UAs 2010-2015 Average

Fishing Gear	Average Quantity (t) 2010-2015	Average Value ($) 2010-2015	Average % of Total Gear Quantities	Average % of Total Gear Values
Project Area UAs				
Fixed Gear				
Pot (trap)	3,077.7	13,768,325	46%	68%
Total Fixed	3,077.7	13,768,325	46%	68%
Mobile Gear				
Shrimp trawl	3,668.3	6,450,620	54%	32%
Bottom otter trawl	5.8	23,421	0%	0%
Purse seine	1.3	354	0%	0%
Total Mobile	3,675.3	6,474,394	54%	32%
Total All Types	6,753.0	20,242,718.8	100%	100%
Adjacent UAs				
Fixed Gear				
Pot	5,150.0	23,121,127	54.0%	74.5%
Gillnet (set or fixed)	100.3	310,458	1.1%	1.0%
Tuck seine	1.4	244	0.0%	0.0%
Total Fixed	5,251.7	23,431,829	55.1%	75.5%
Mobile Gear				
Shrimp trawl	3,927.4	6,980,989	41.2%	22.5%
Bottom otter trawl	341.4	629,872	3.6%	2.0%
Purse seine	16.3	4,751	0.2%	0.0%
Total Mobile	4,285.1	7,615,612	44.9%	24.5%
Total All Types	9,536.8	31,047,440.2	100.0%	100.0%

In general, fixed-gear, which is usually left unattended in the water while it fishes (or “soaks”) presents a greater potential for interaction with ships or other submerged equipment. For bottom-positioned gear, such as crab pots or halibut longlines, the gear-conflict risk is from encountering the ropes which hold the surface buoys marking the ends of sets or fleets of gear on the ocean bottom. For surface set gear, such as large pelagic longlines that float very near the surface, and may extend for dozens of miles, the potential for interaction is fouling or cutting lines. Conversely, the potential for mobile gear interaction is very low if the project vessels/platforms and fishing boats communicate at sea as they are required to do, since mobile gear is always tended, towed by or operated from a ship at sea.

The following maps show domestic harvesting locations by fixed gear (Figures 7.22) and by mobile gear (Figure 7.23) for all years 2010-2015. Note that although the redacted datasets provided by DFO containing quantity and value data do not show numbers for mobile gear in 2015 (Table 7.12), the geolocational database does indicate mobile gear harvesting locations for that year.

The maps contained in Figures 7.24 and 7.25 show the same locational data, but sequenced by three-month periods to provide an understanding of how the gear types and locations may vary by season. As they indicate, fixed gear harvesting is much more widespread during the April to September period, while the mobile gear fisheries locations tend to be generally widespread through all quarters of the year. As do the previous maps, these show comparatively little domestic harvesting within the Project Area, and, with the continuing absence of shrimp trawlers, the level of mobile gear fishing activity in the general area will likely be lower than in the period before 2014.

Figure 7.22 Fixed Gear Harvesting Locations, 2010-2015

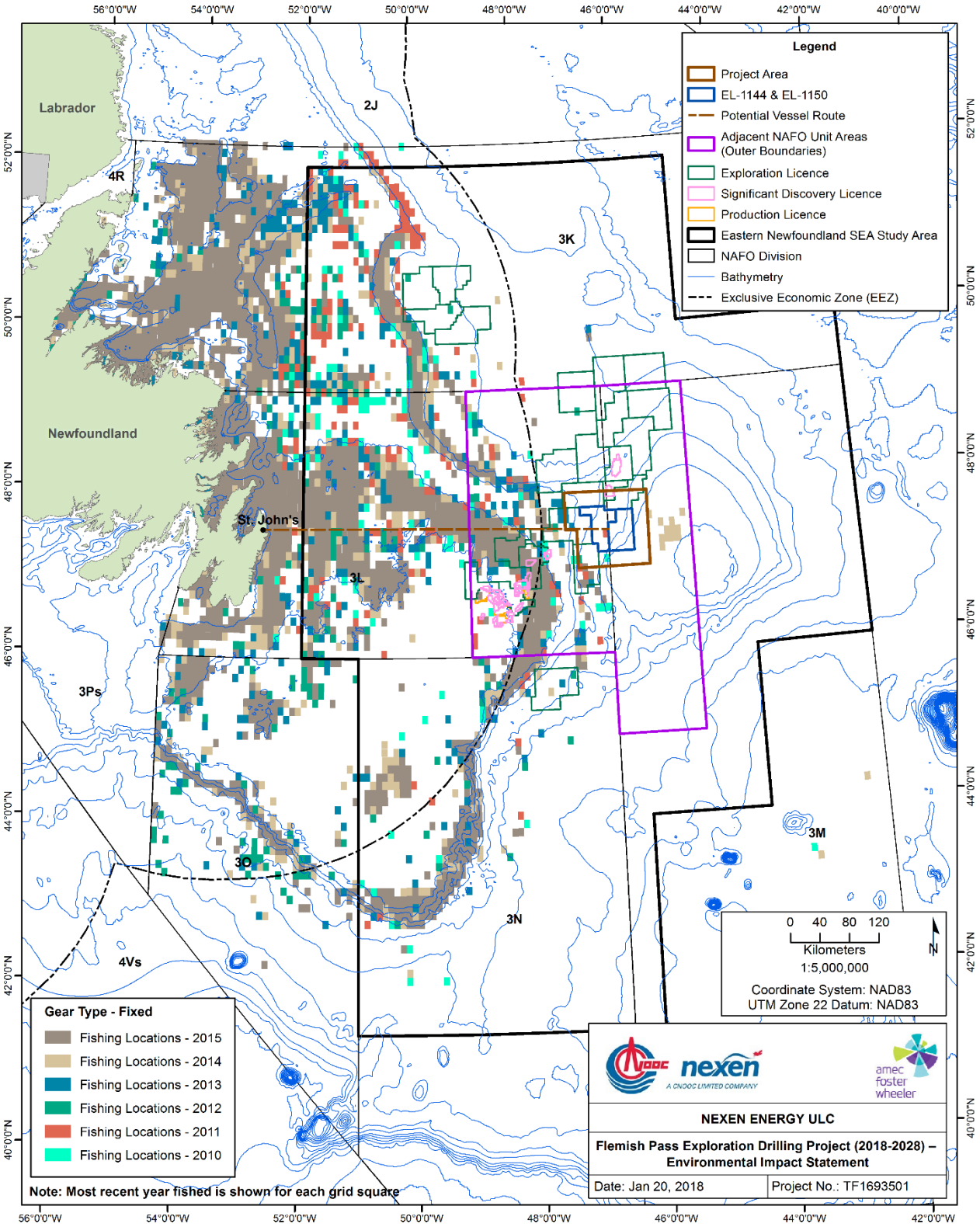


Figure 7.23 Mobile Gear Harvesting Locations, 2010-2015

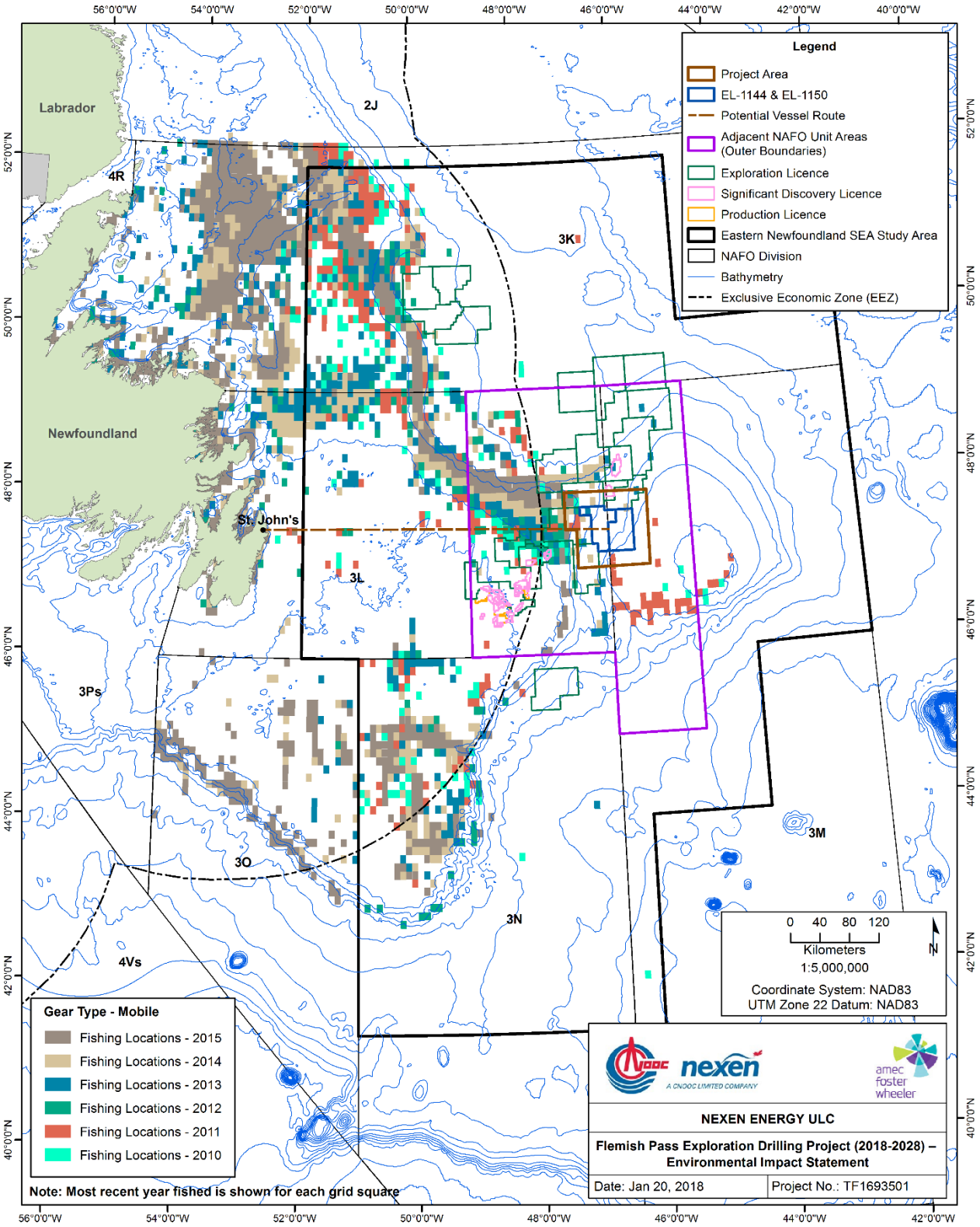


Figure 7.24 Fixed Gear Harvesting Locations, by Quarter, 2010-2015

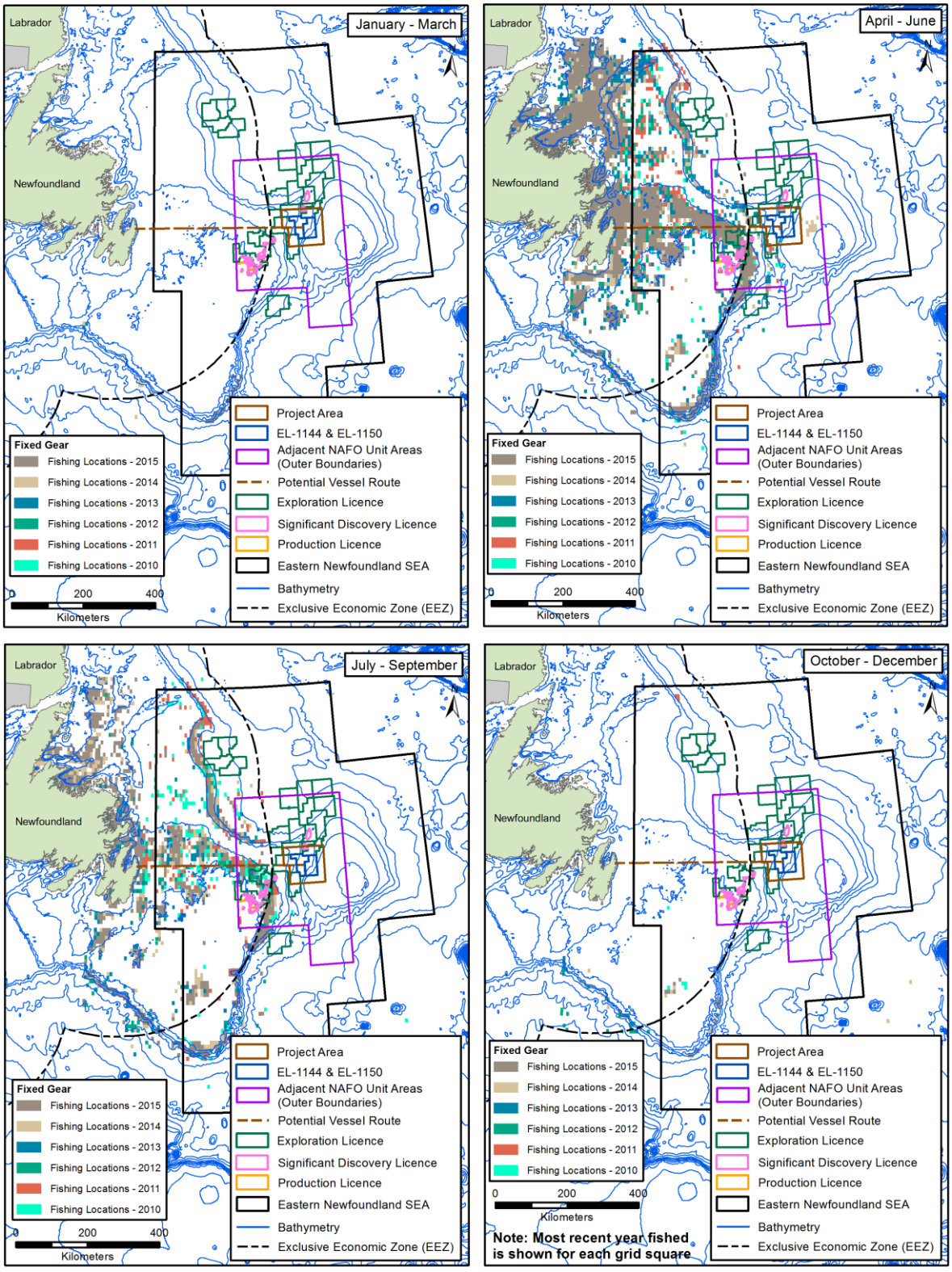
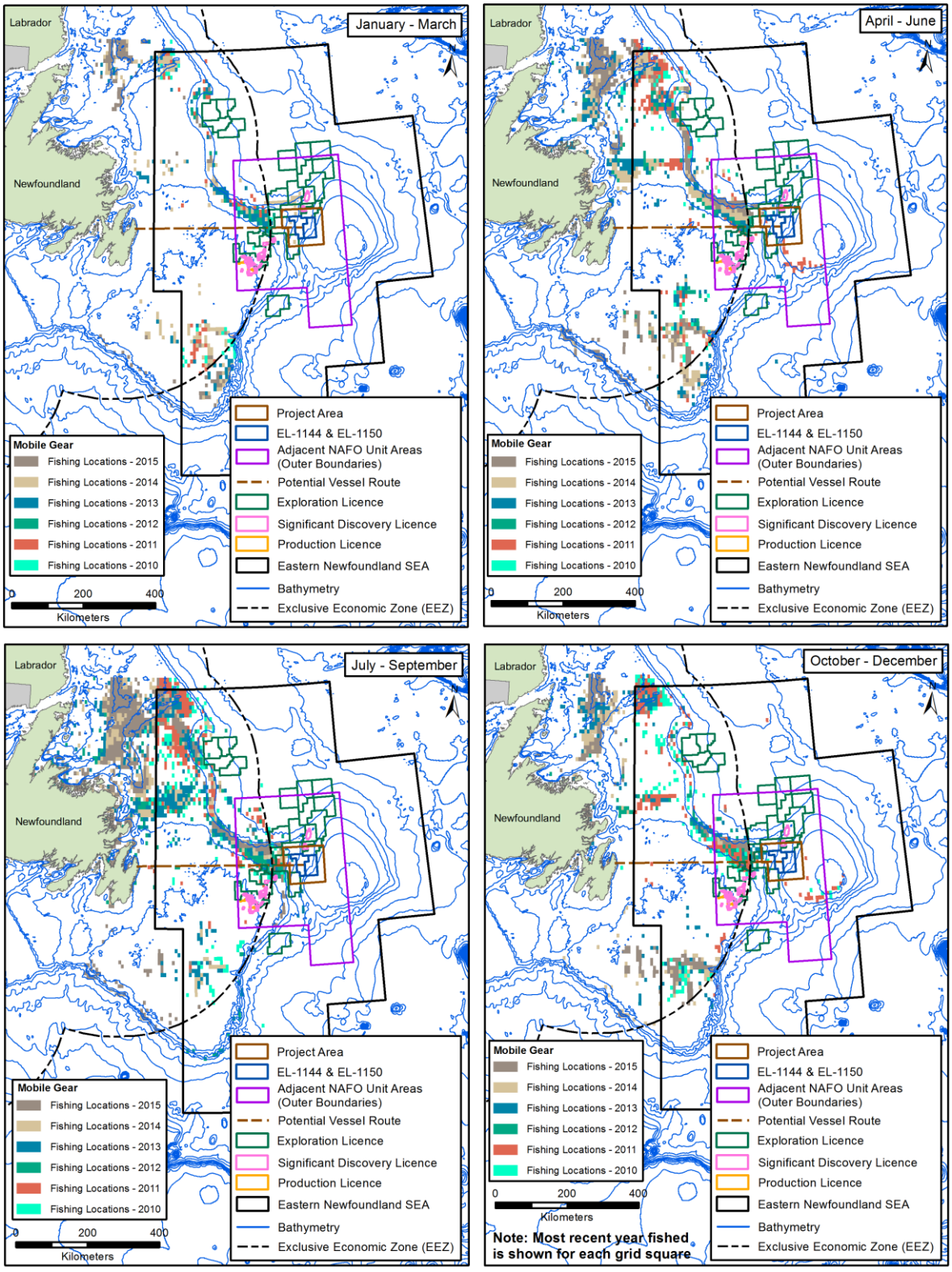


Figure 7.25 Mobile Gear Harvesting Locations, by Quarter, 2010-2015



7.2.4.4 Seasonality

As the previous maps demonstrate, fishing activity and locations can vary substantially throughout the year, particularly for fixed-gear harvesters. The timing of the various fisheries depends on many factors, such as open and closed management seasons, market cycles, individual fishing enterprise business decisions and priorities, the availability of the targeted resource at the time, and – understandably – the weather. The last factor is especially important for smaller fishing vessels and for fixed-gear fisheries. As Section 5.5 illustrates, the warmer months tend to be more reliable for good sailing conditions.

While some Project Area fisheries (such as shrimp harvesting in the past, and for several groundfish species) are open year-round, others (most importantly, for snow crab) have a fairly well-defined open season, usually within the April to July period in this area.

The following graphs (Figures 7.26 and 7.27) show the average reported domestic harvest quantity and value by month for the 2010-2015 period from within the Project Area UAs and the Adjacent UAs. Most harvesting from January to April and October to December employs mobile gear, while the summer months are dominated by the fixed gear fishery for snow crab in these areas. The sub-sections on the key species fisheries (below) provide more detailed information about the nature and timing of those fisheries.

The maps that follow (Figures 7.28 to 7.39) also show the location of harvesting activity by month using the same locational datasets described previously. Figure 7.40 then indicates the fishing intensity levels by quarter using the same methods as described above.

Figure 7.26 All Species, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average

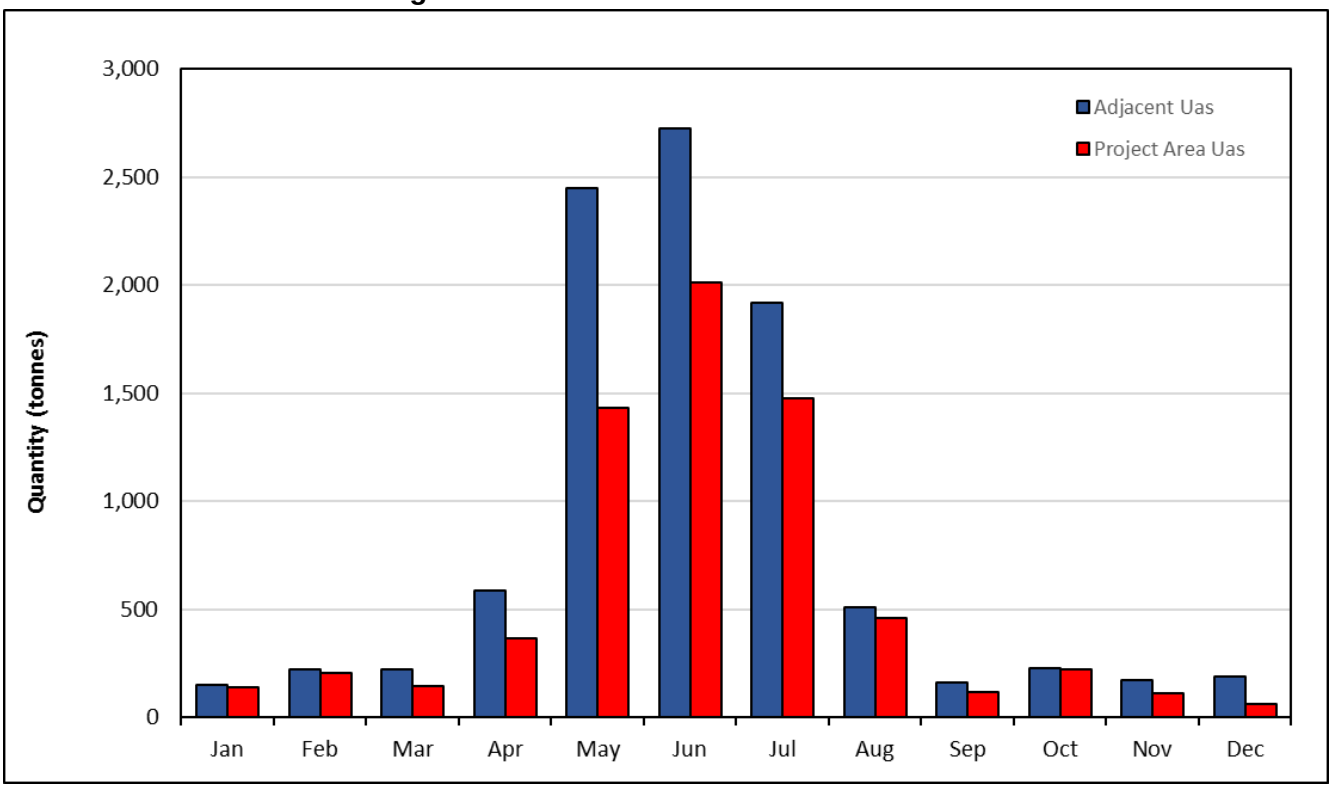


Figure 7.27 All Species, Project Area UAs and Adjacent UAs Value of Harvest by Month, 2010-2015 Average

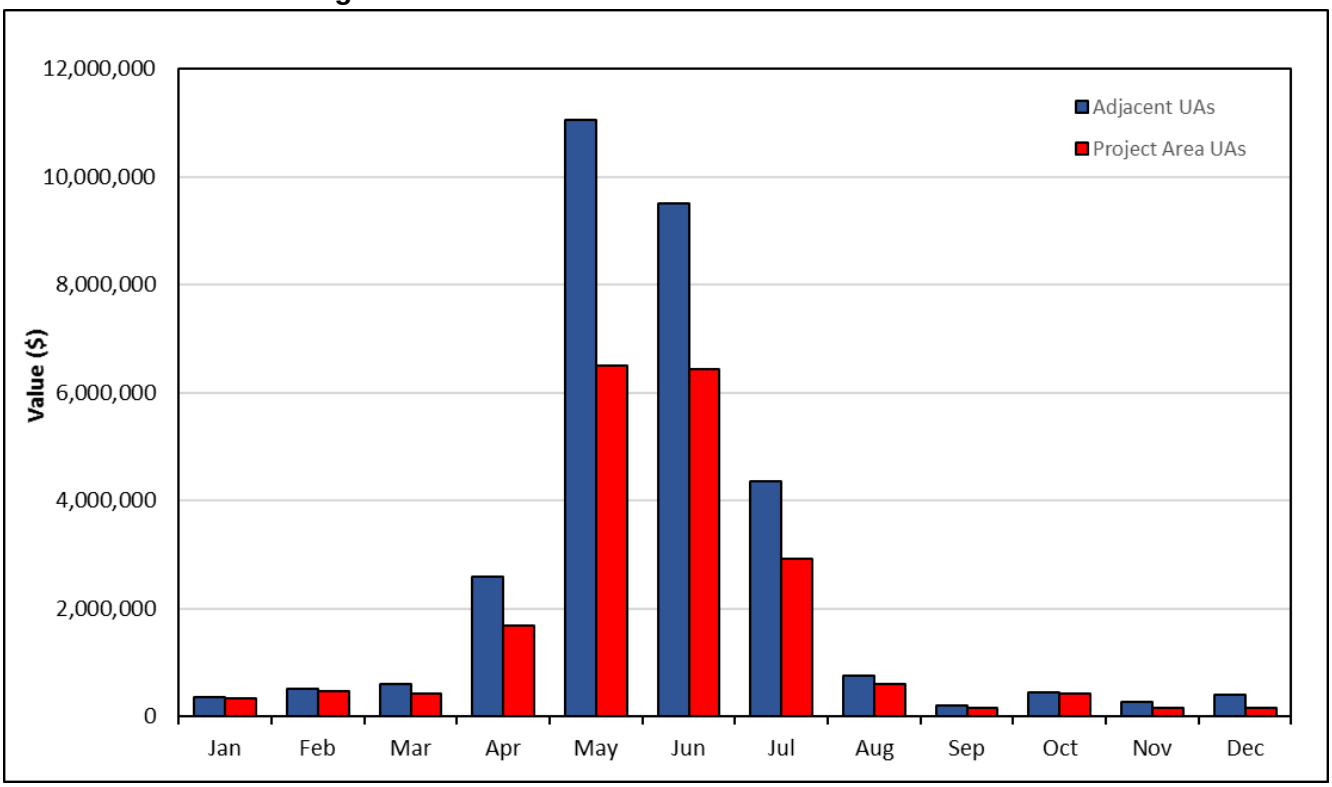


Figure 7.28 All Species Harvesting Locations, January 2010 – 2015

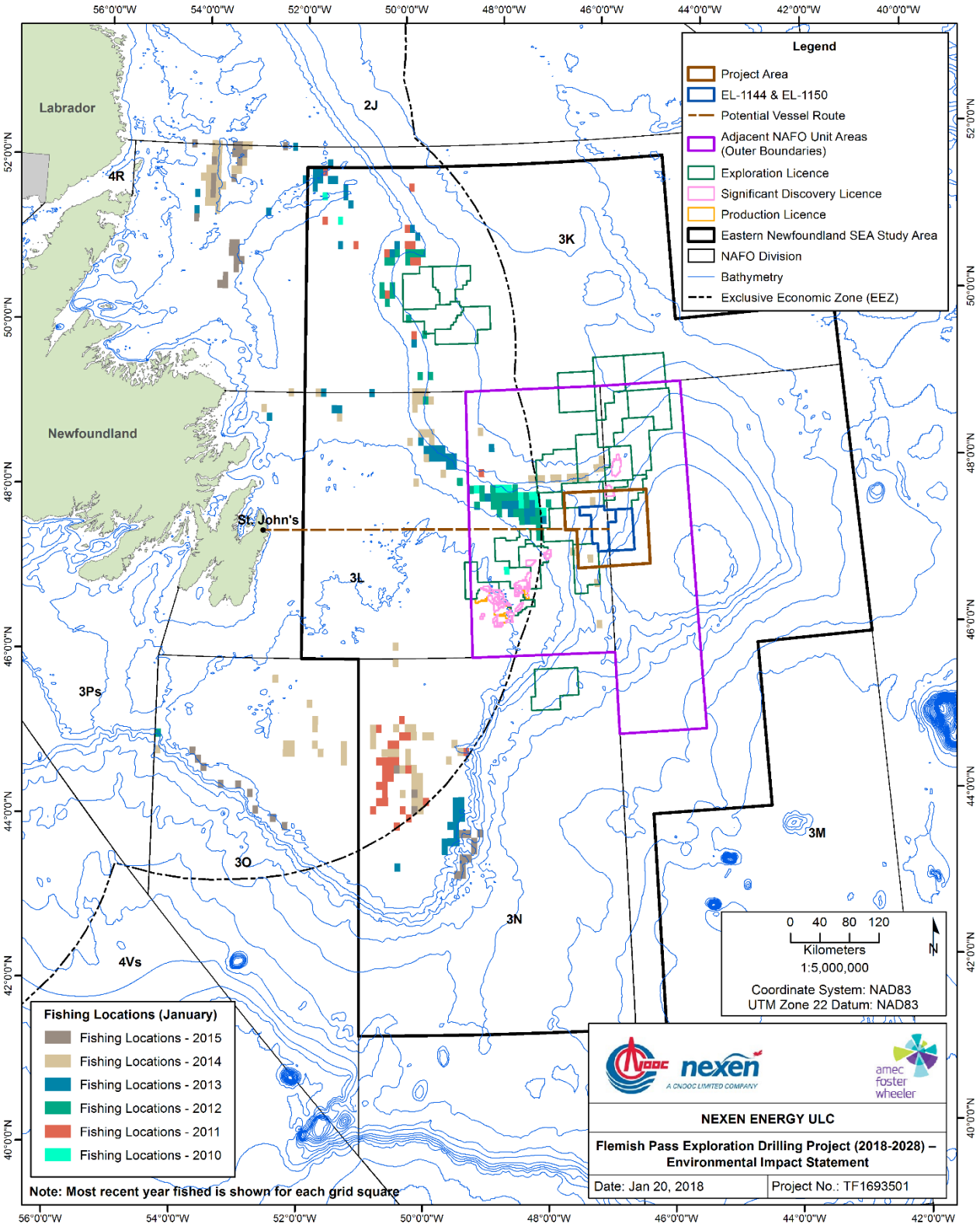


Figure 7.29 All Species Harvesting Locations, February 2010 – 2015

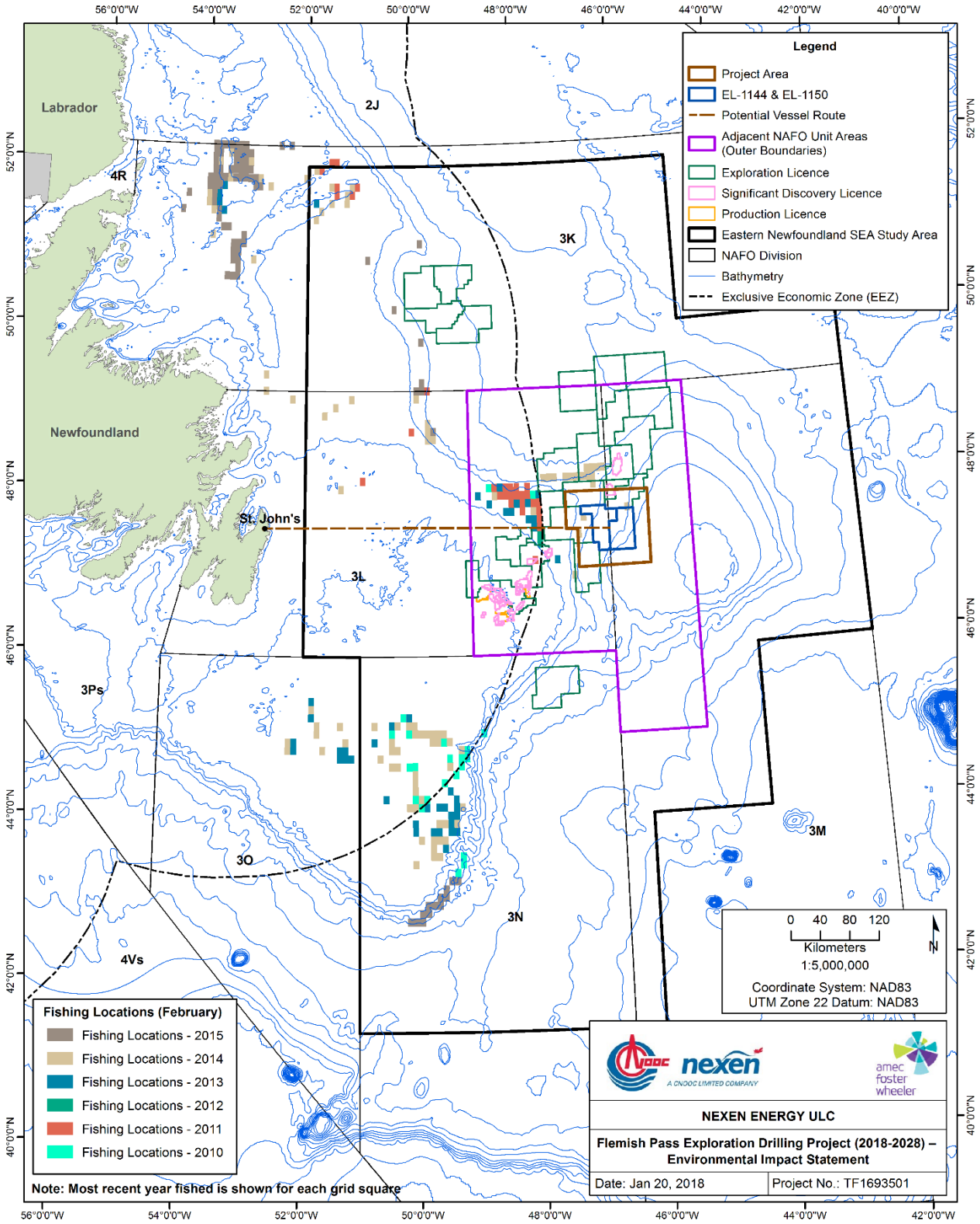


Figure 7.30 All Species Harvesting Locations, March 2010 – 2015

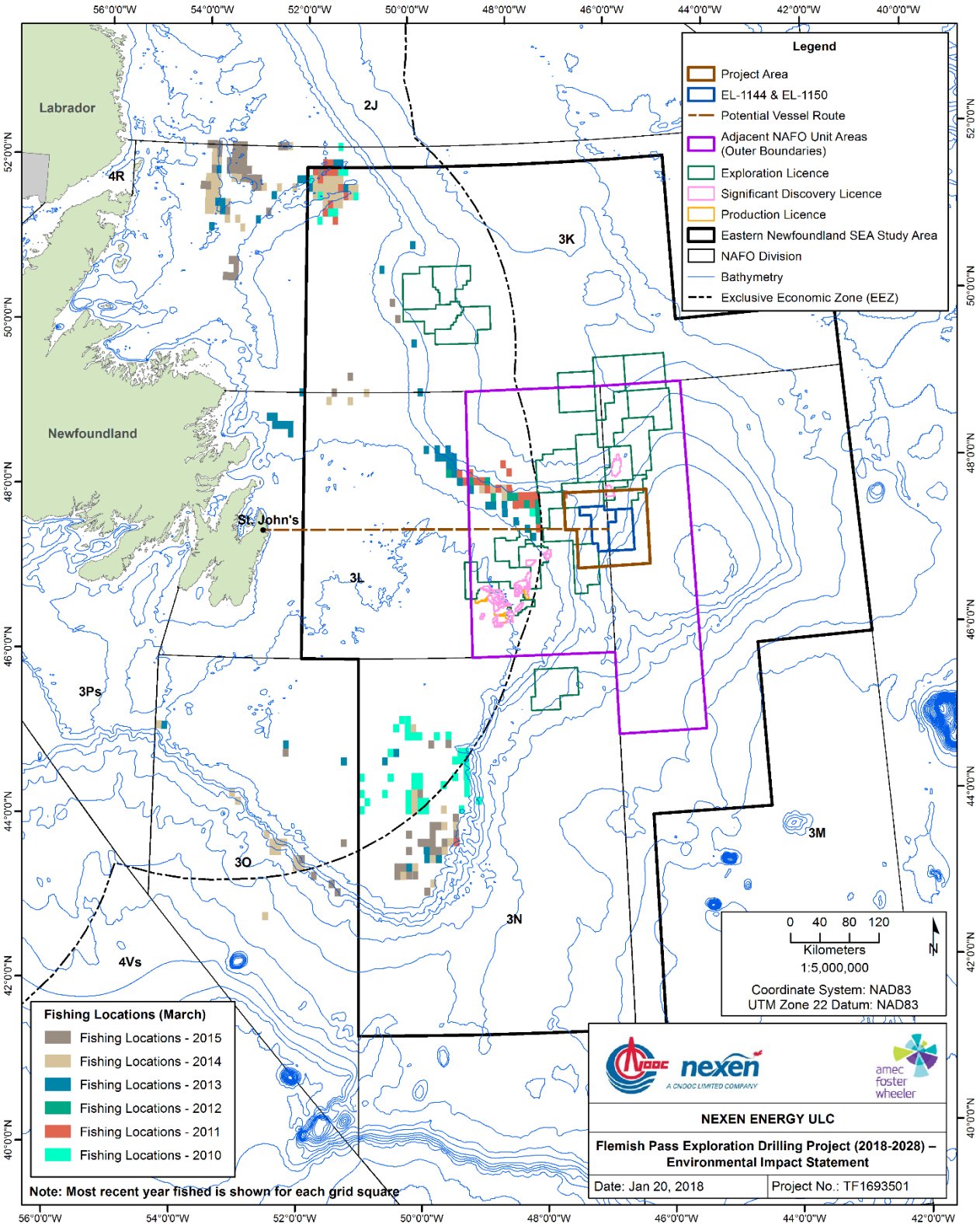


Figure 7.31 All Species Harvesting Locations, April 2010 – 2015

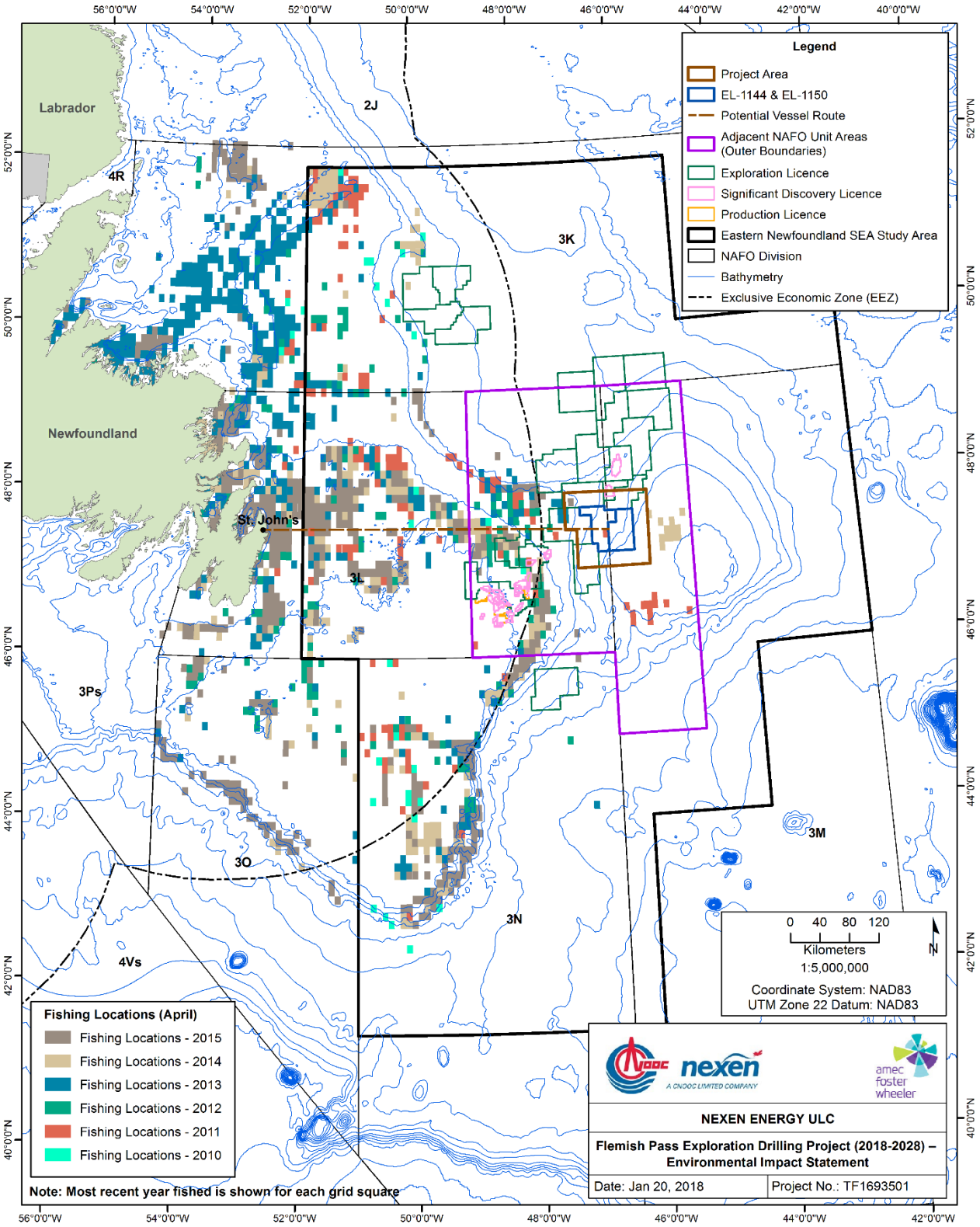


Figure 7.32 All Species Harvesting Locations, May 2010 – 2015

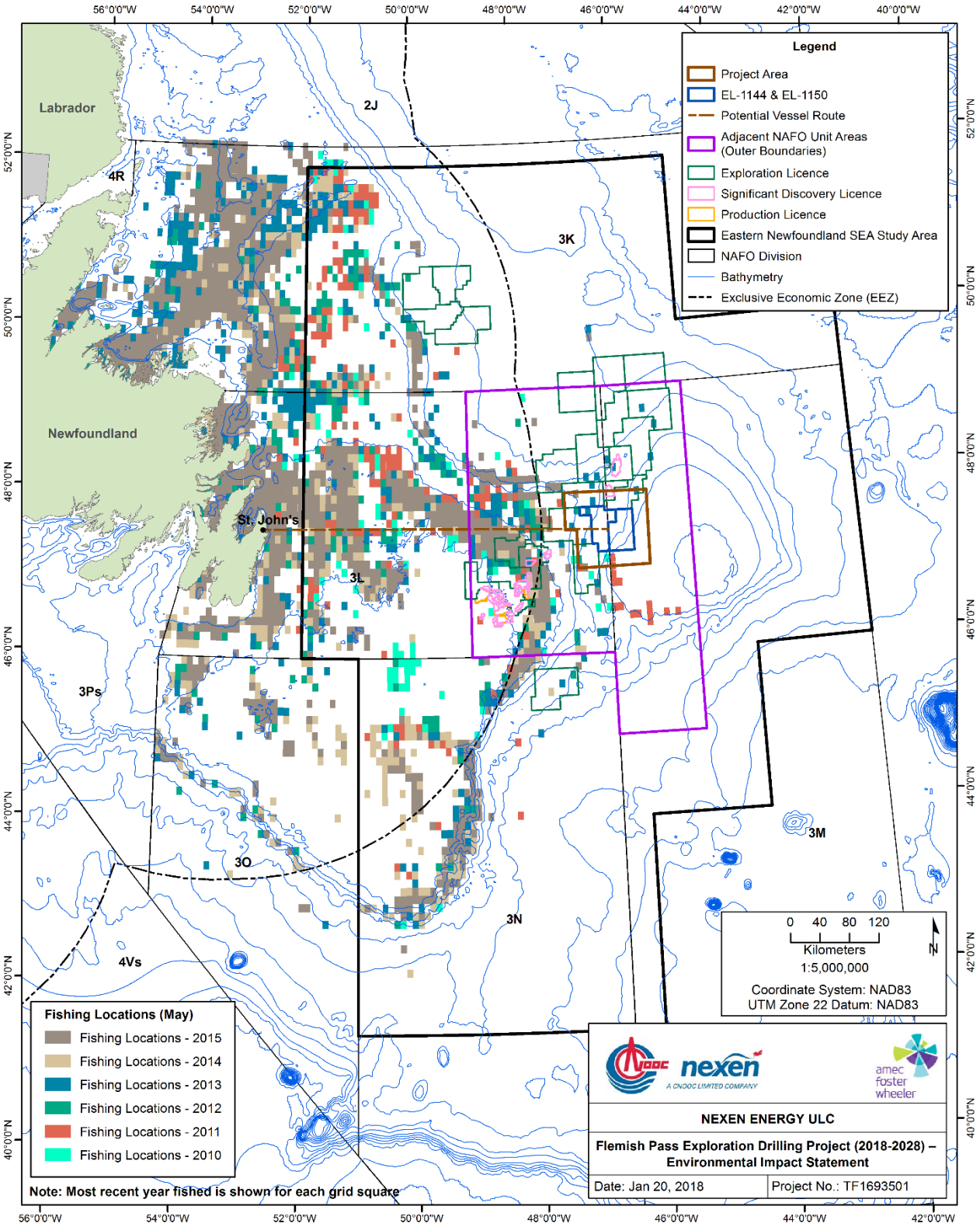


Figure 7.33 All Species Harvesting Locations, June 2010 – 2015

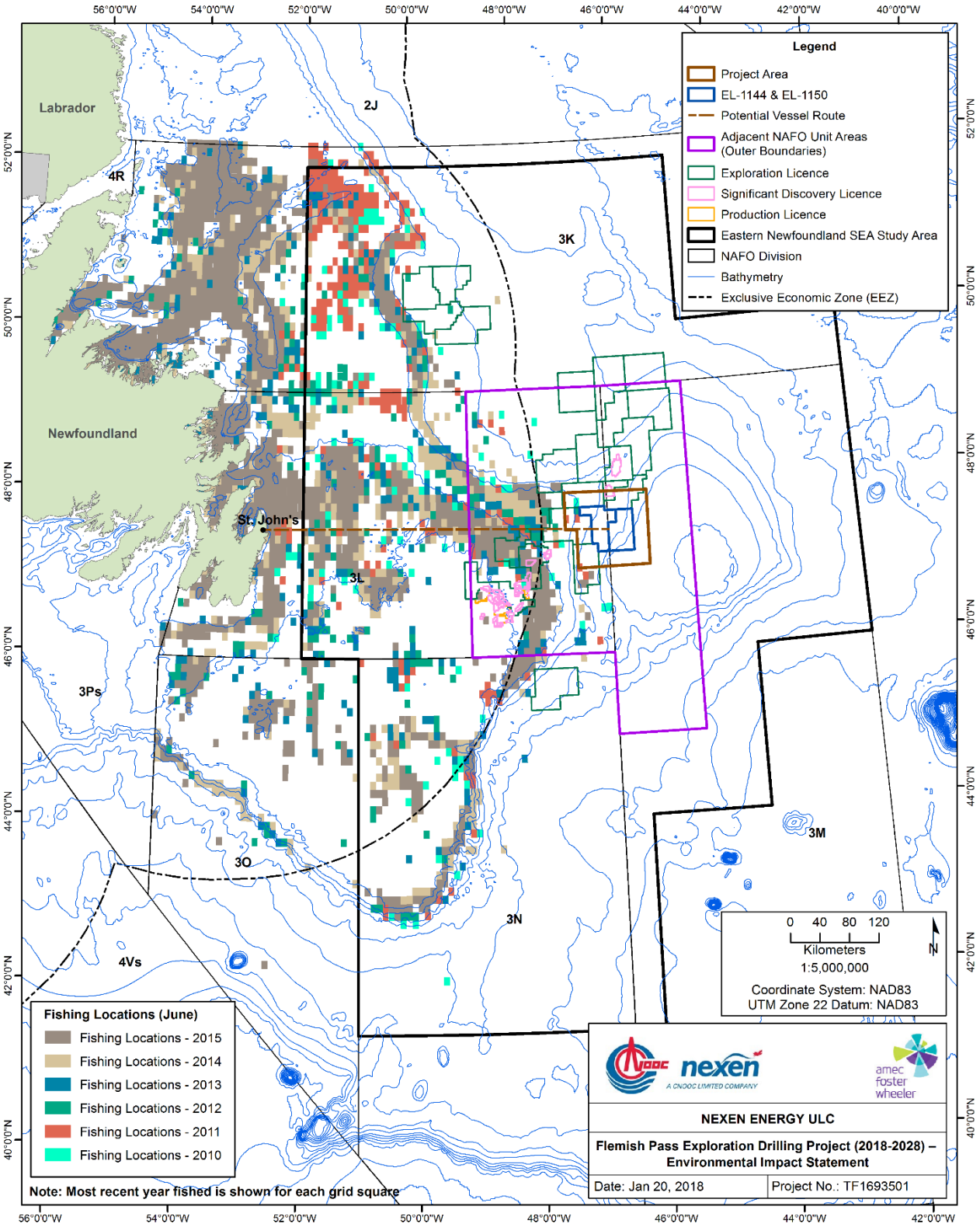


Figure 7.34 All Species Harvesting Locations, July 2010 – 2015

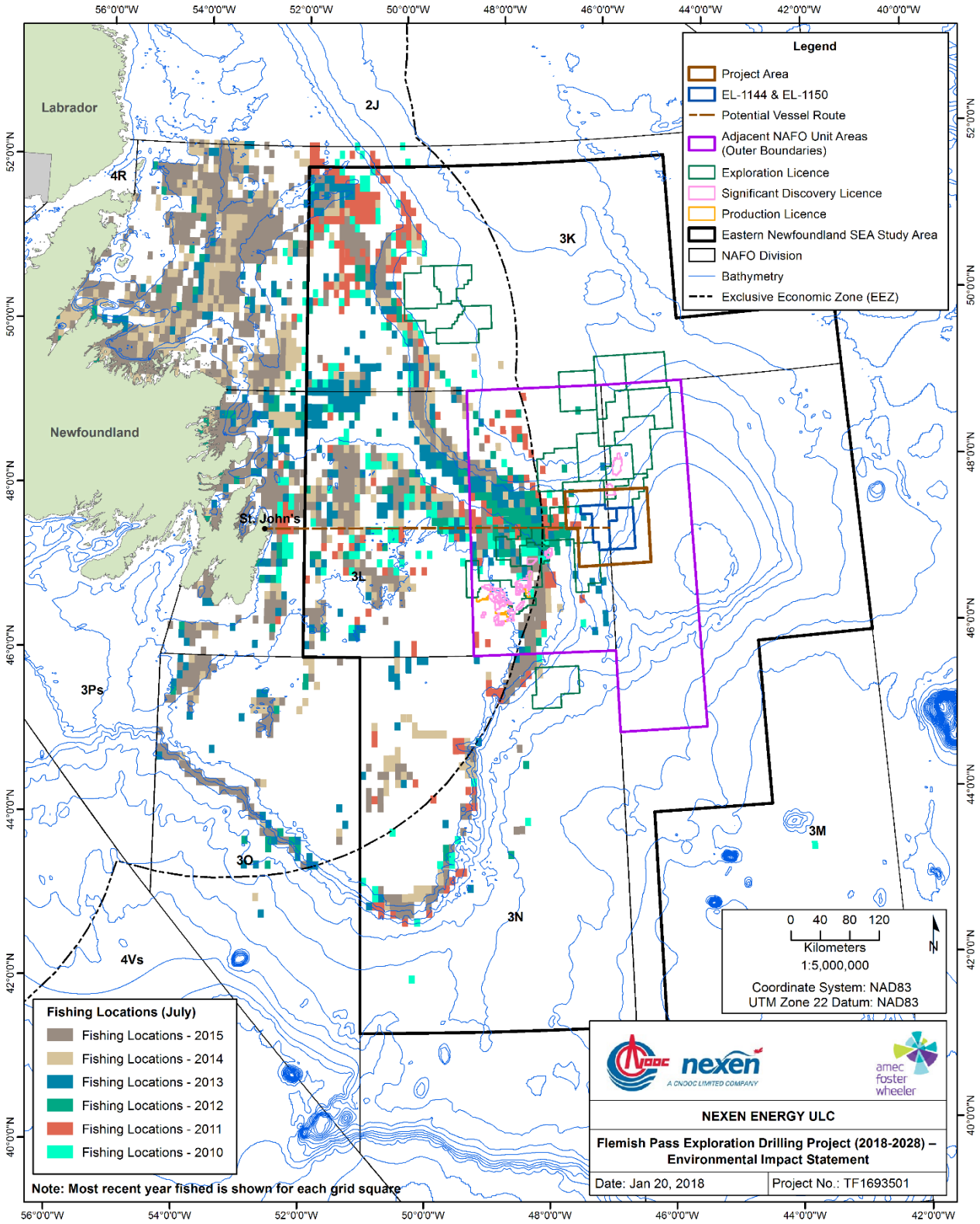


Figure 7.35 All Species Harvesting Locations, August 2010 – 2015

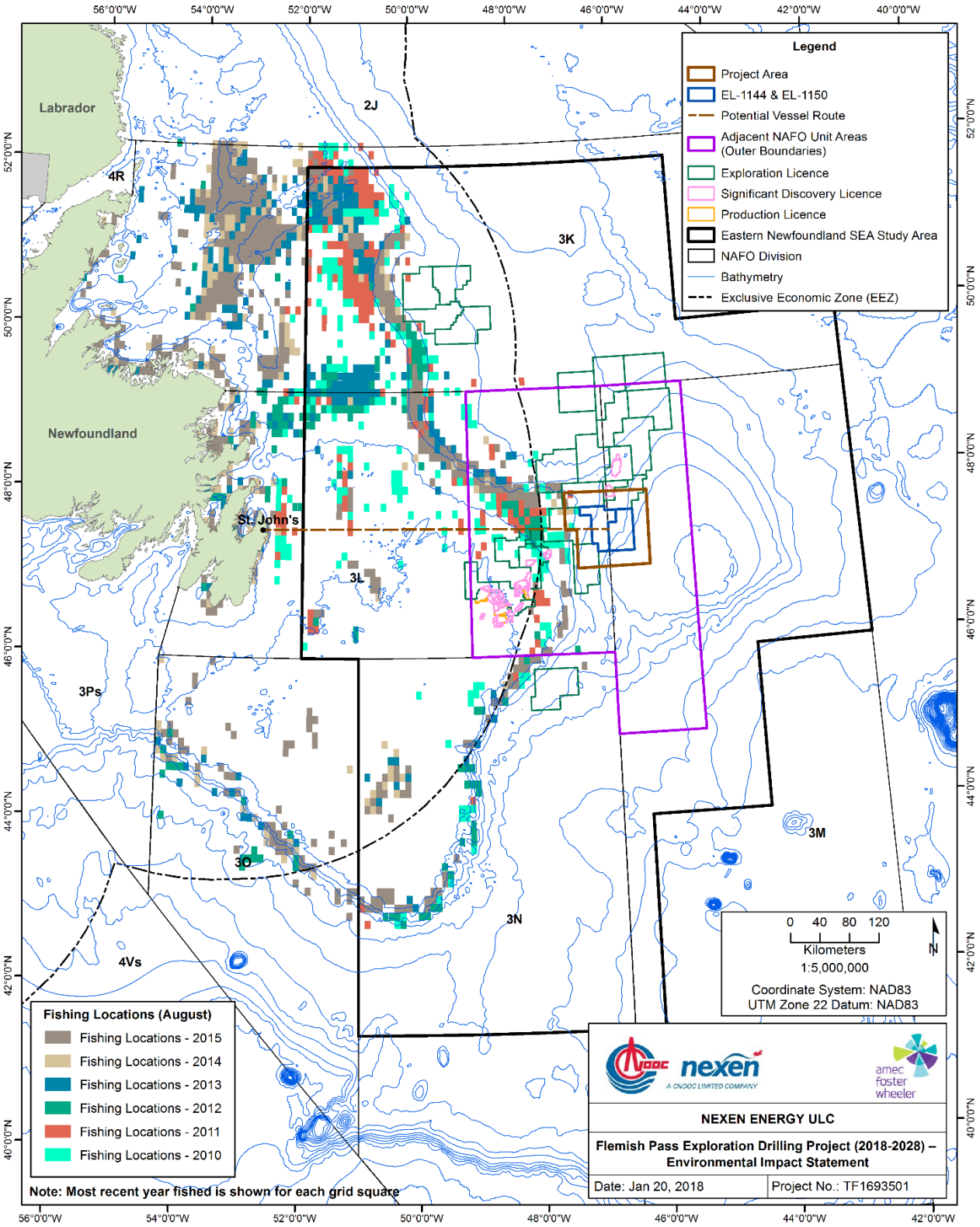


Figure 7.36 All Species Harvesting Locations, September 2010 – 2015

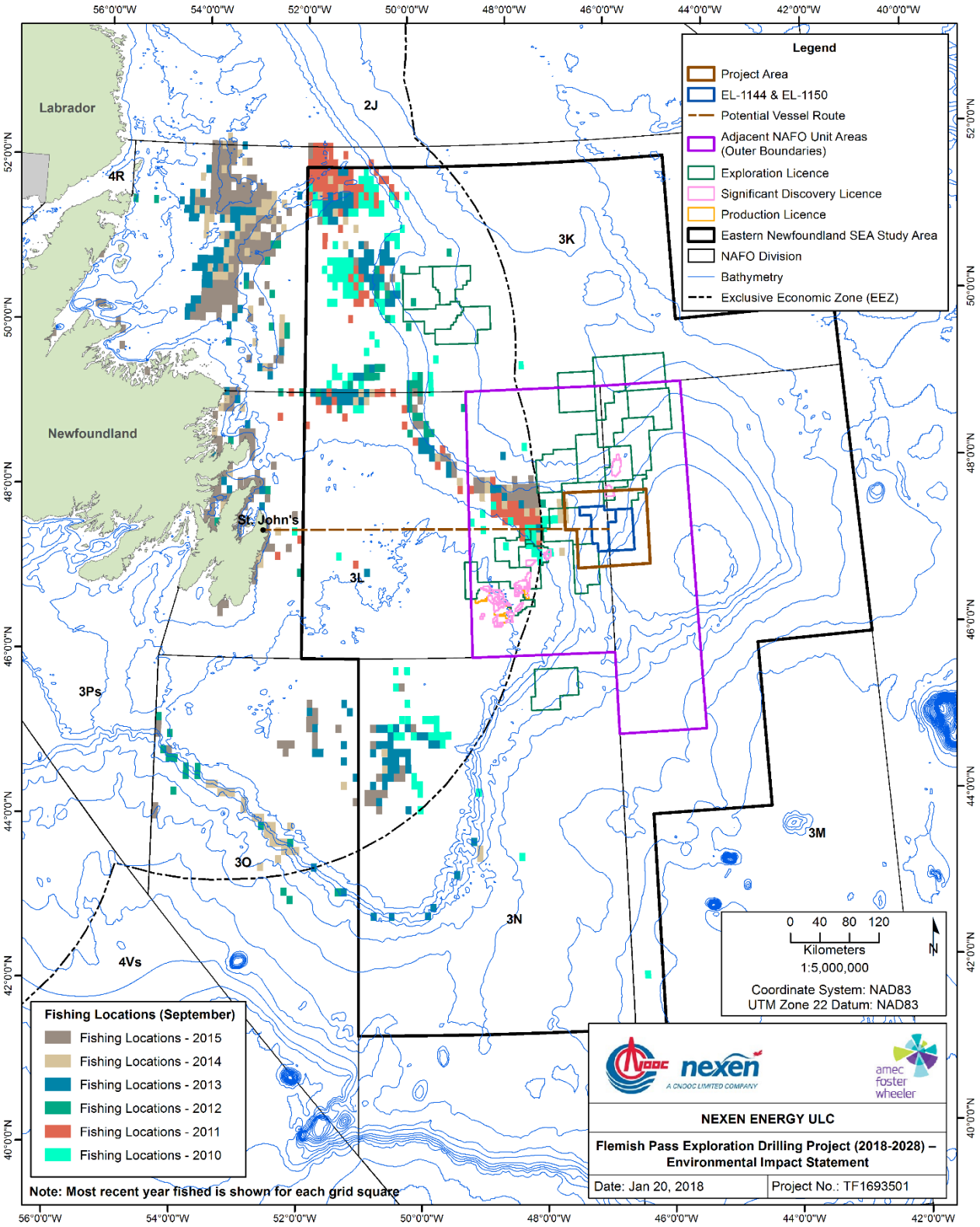


Figure 7.37 All Species Harvesting Locations, October 2010 – 2015

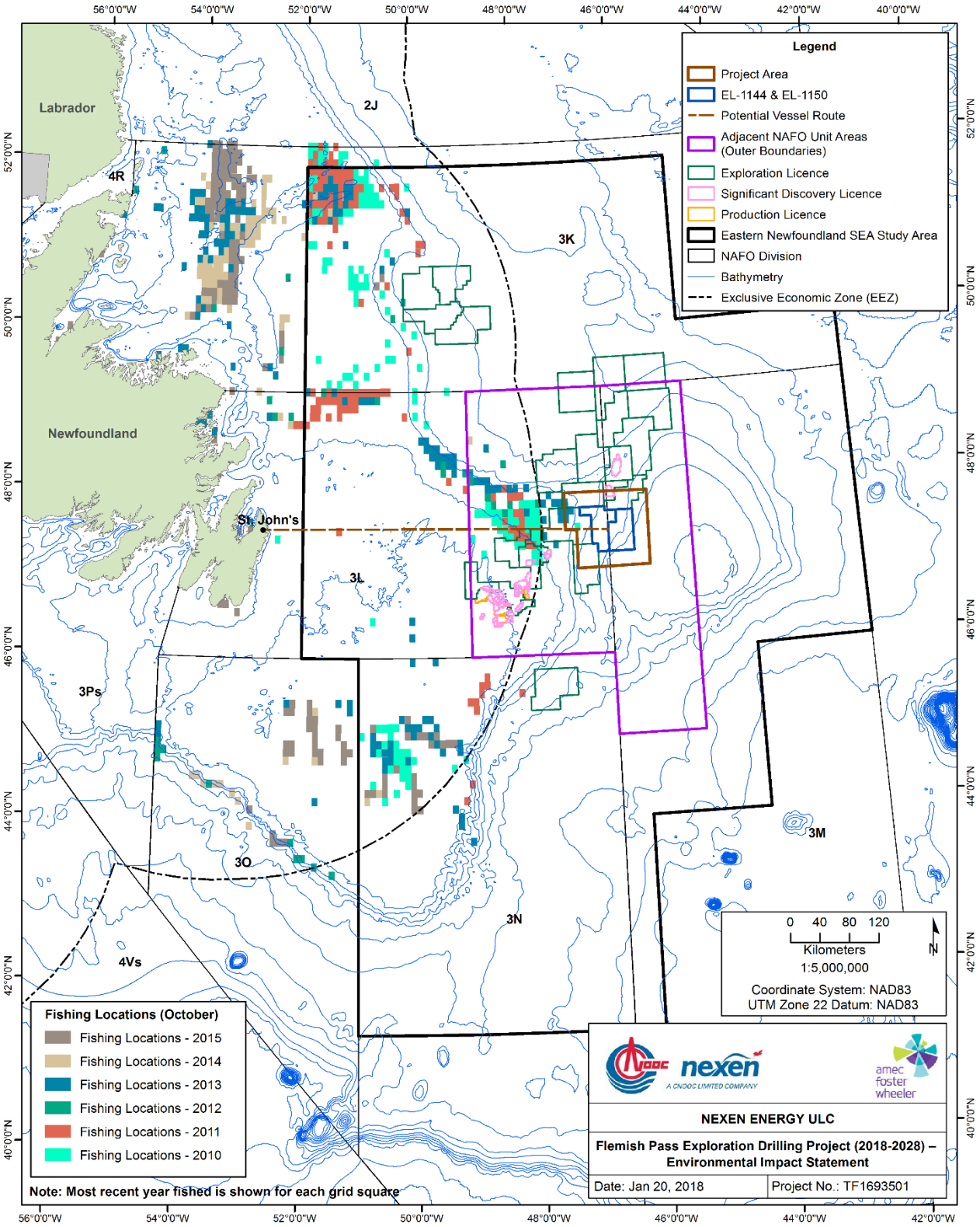


Figure 7.38 All Species Harvesting Locations, November 2010 – 2015

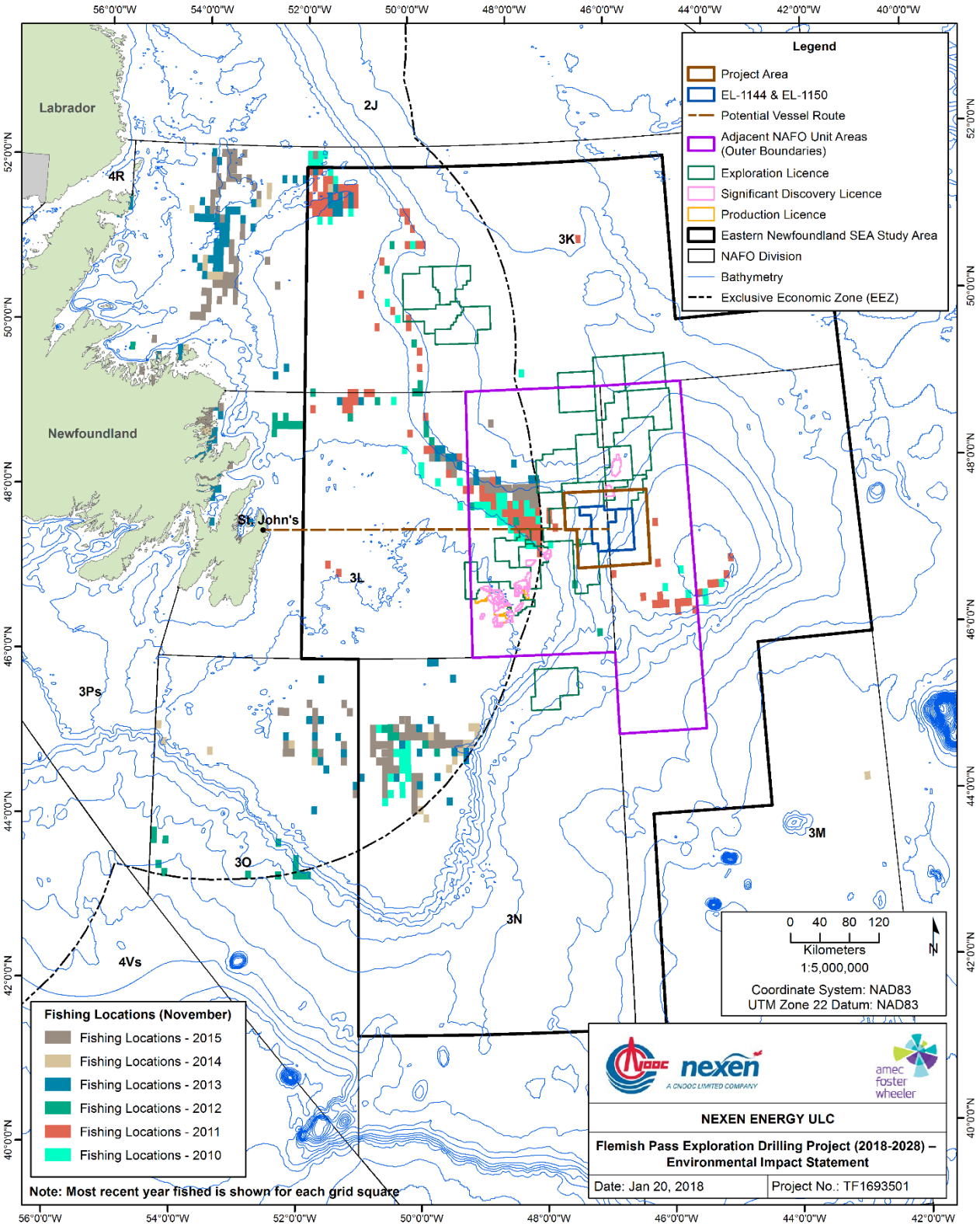


Figure 7.39 All Species Harvesting Locations, December 2010 – 2015

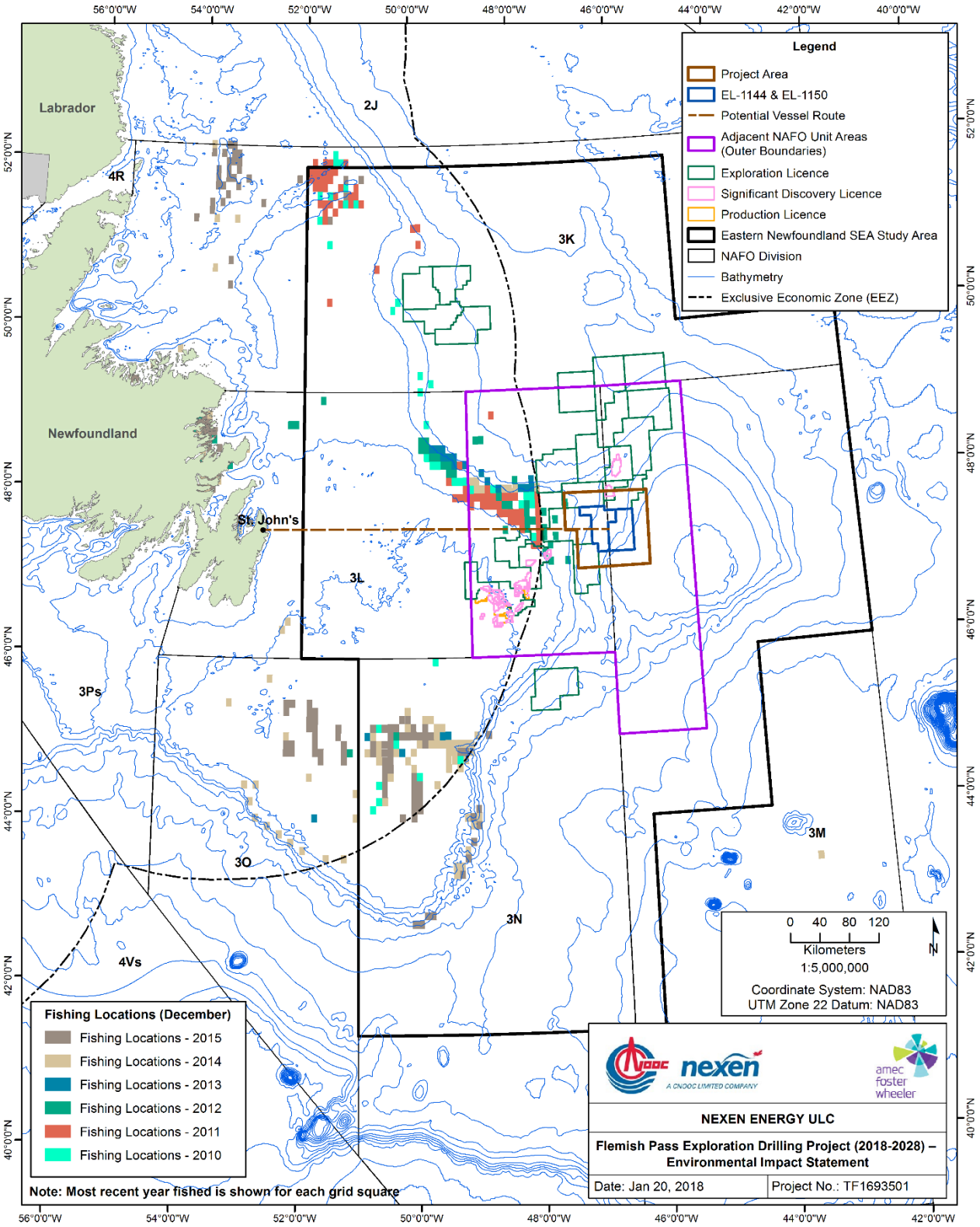
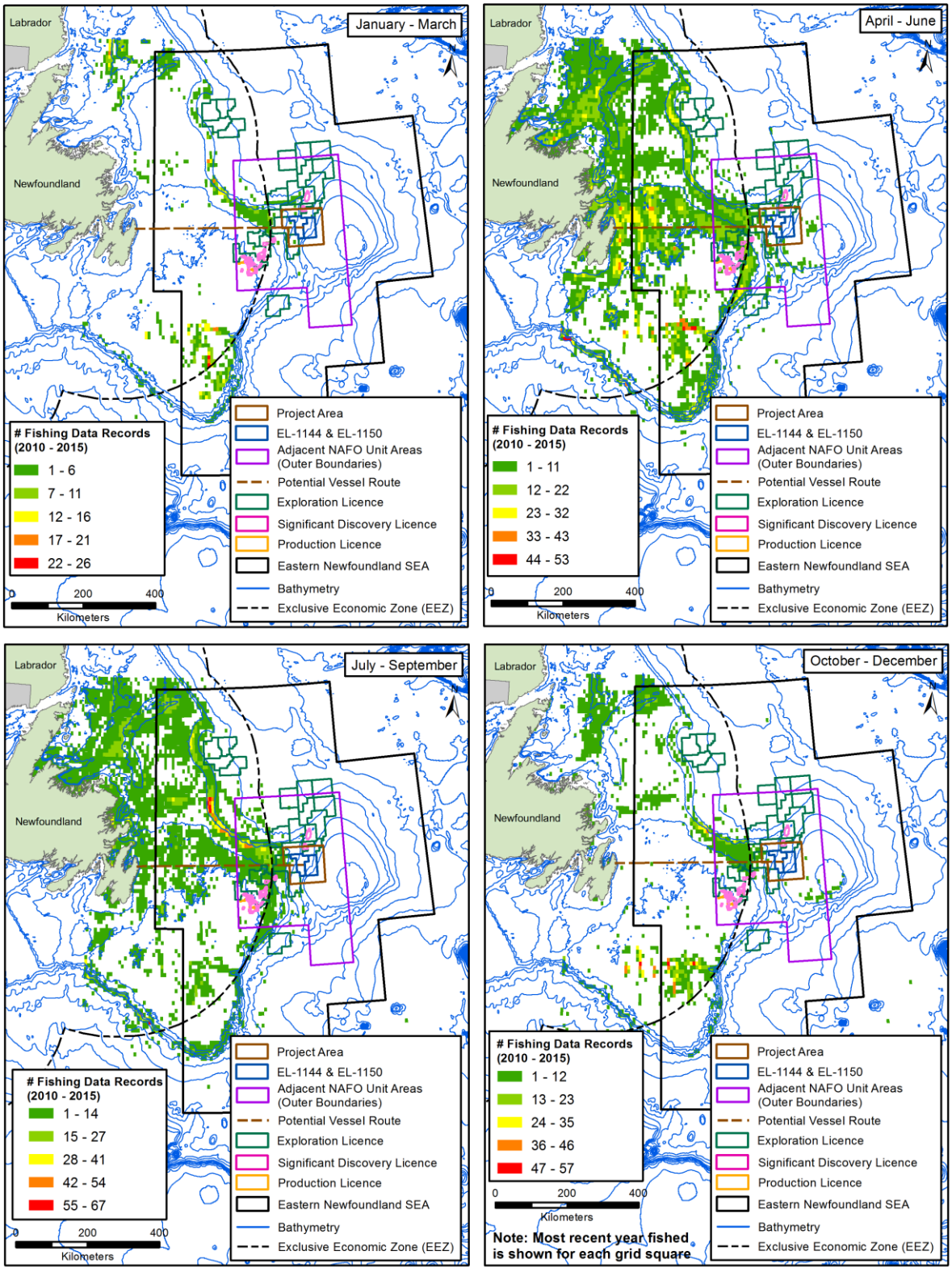


Figure 7.40 Commercial Harvesting Intensity by Locations, All Species, by Quarter 2010-2015



7.2.4.5 Key Fisheries

As previous sections have shown, the domestic fisheries on the eastern Grand Banks have been dominated by shellfish (snow crab and northern shrimp) in terms of both quantity and value since the mid-1990s. Snow crab is now the principal species, but Northern shrimp had been very important until that fishery was closed in the region. Nearly all the other catches have been groundfish, some in directed fisheries (such as redfish) and others as an allowed by-catch (such as Atlantic cod). The following provides additional information about key fisheries as determined by-catch quantities and values.

Snow/Queen Crab

The snow crab fishery is now the most substantial domestic fishery within the Project Area and in most other parts of the region. Since the 1990s groundfish closures, it has continued to increase in relative importance, which has been emphasized recently by stronger prices. By the 2010 to 2015 period, snow crab made up approximately 54 percent of the Adjacent UAs' harvest by weight and nearly 75 percent of its landed value, and 48 percent and 68 percent, respectively, within the Project Area UAs. In 2015, after the closure of shrimp harvesting, snow crab accounted for 100 percent of the reported catch in both areas. Landings during the 2015 season marked an all-time high in the Divisions 3L, 3N and 3O offshore snow crab harvest with landings of 28,750 tonnes (DFO 2016a).

Throughout the entire province of Newfoundland and Labrador that year, there were about 2,600 licence holders within several vessel fleets, operating under management measures that included trap limits, quotas, trip limits, designated fishing areas, onboard vessel monitoring systems (VMS) for the offshore fleets, and limited seasons. For 2016, season dates were set for April 4 to July 31 in Division 3NLOP, although the time was extended until early August in some areas. The set dates for 2017 were April 6 to July 31 (DFO 2016a, 2017a).

Crab fishing gear is typically set in 50 to 600 m water depths, most from boats less than 20m in length. It consists of conical baited crab pots (traps) that are weighted on the sea floor and attached to surface buoys by ropes/lines, often in strings with many traps between buoys. Snow crab gear strings may have a "highflyer" radar reflector at one end and a large buoy at the other end. A 50-60 trap string may range in length from 1.8-km to 2.3-km long. Traps may be left unattended several days or longer if weather makes it difficult to retrieve the catch (DFO 2013a, 2016a).

Although the 2015 season marked an all-time high in the region, science surveys late that year indicated potential problems with pre-recruits and biomass in several areas. For 2016, there was a total allowable catch (TAC) of 33,486 tonnes for all of Division 3LNO, which was an overall 6 percent reduction from 2015, and in management zones beyond 200 NM, the reduction was 20 percent. In early 2017 DFO reported more serious concerns about the stock status, indicating that 3LNO biomass had declined to an historic low, down 74 percent from 2015-2016 in some management areas (DFO 2016a, 2016b; Navigator 2017).

The 2017 TAC and management area quotas were announced in April after extensive consultation between DFO and the fishing Industry; the outcome was a further reduction from 2016, by 46 percent in areas outside the EEZ and 23 percent in other areas (DFO 2017a). Table 7.13 shows the 2015 and

2017 quotas for the relevant crab fisheries management areas (Figure 7.43 indicates these area locations).

Table 7.13 Regional Snow / Queen Crab Quotas for 2015 and 2017

Management Area	Description	Quota (tonnes) 2015	Quota (tonnes) 2017	Percent Change from 2015
8B	Southern Avalon (offshore)	800	640	-20%
MS/EX	Mid-shore extended	3,780	3,024	-20%
3L EX	Between 170 and 200 miles	2,822	2,117	-25%
3L 200	3L Outside 200 miles	2,053	985	-52%
3N 200	3N Outside 200 miles	2,527	1,011	-60%
3NO 200	3NO Outside 200 miles (> 65' boats)	920	368	-60%
Total		12,902	8,145	-37%
Source: DFO (2015a, 2017a)				

As Figure 7.41 shows, the fishery has been widespread along parts of the Newfoundland Shelf, the Flemish Pass, and the northern, eastern and southern edges of the Grand Banks. DFO research also indicates that the upper slopes in the northern half of the Adjacent UAs are amongst the most productive in terms of quantity per trip (Mullowney et al 2016). Figure 7.41 show the annual snow crab harvest (available data) in the areas for 2010-2015, and Figures 7.42 indicates the timing of the harvest (averaged) for those years.

Figure 7.41 Snow/Queen Crab, Project Area UAs and Adjacent UAs Quantity of Harvest by Year, 2010-2015

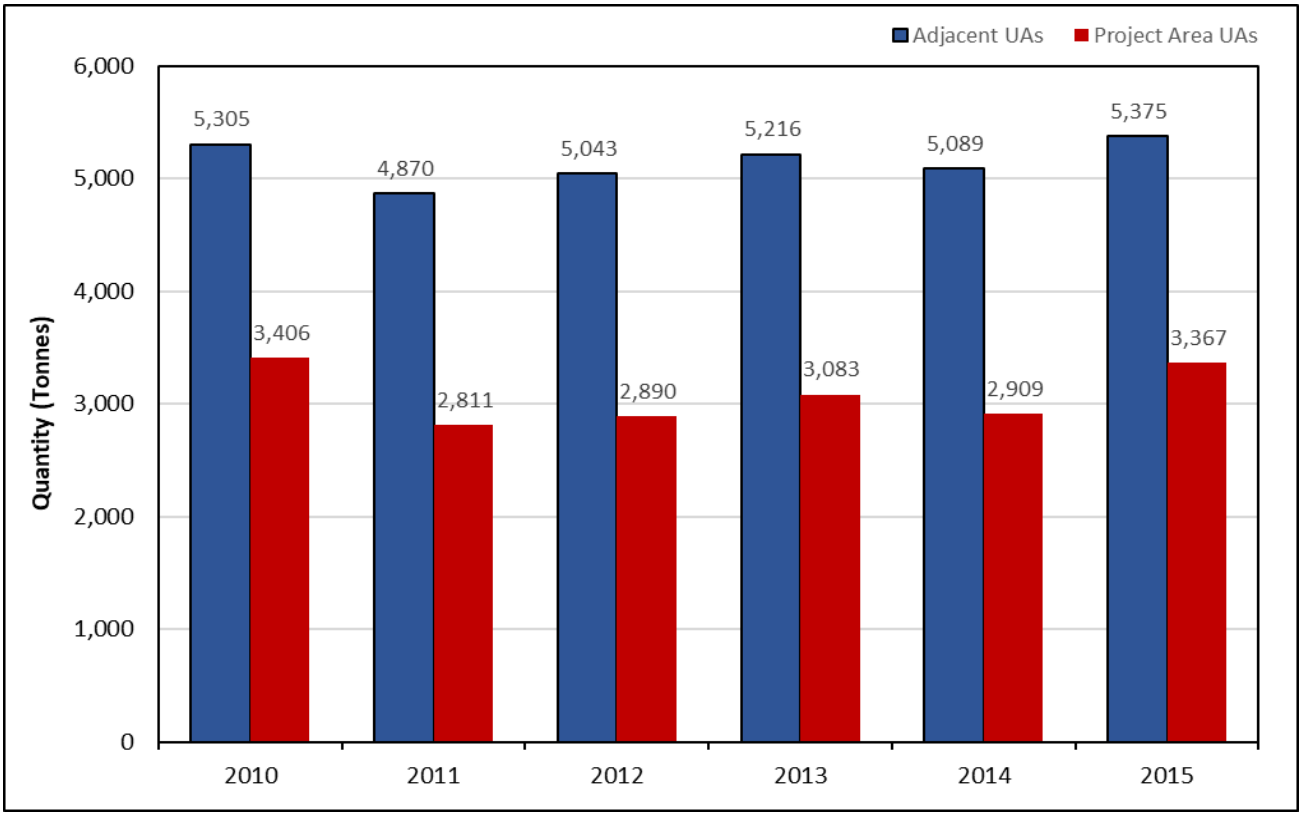


Figure 7.42 Snow/Queen Crab, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average

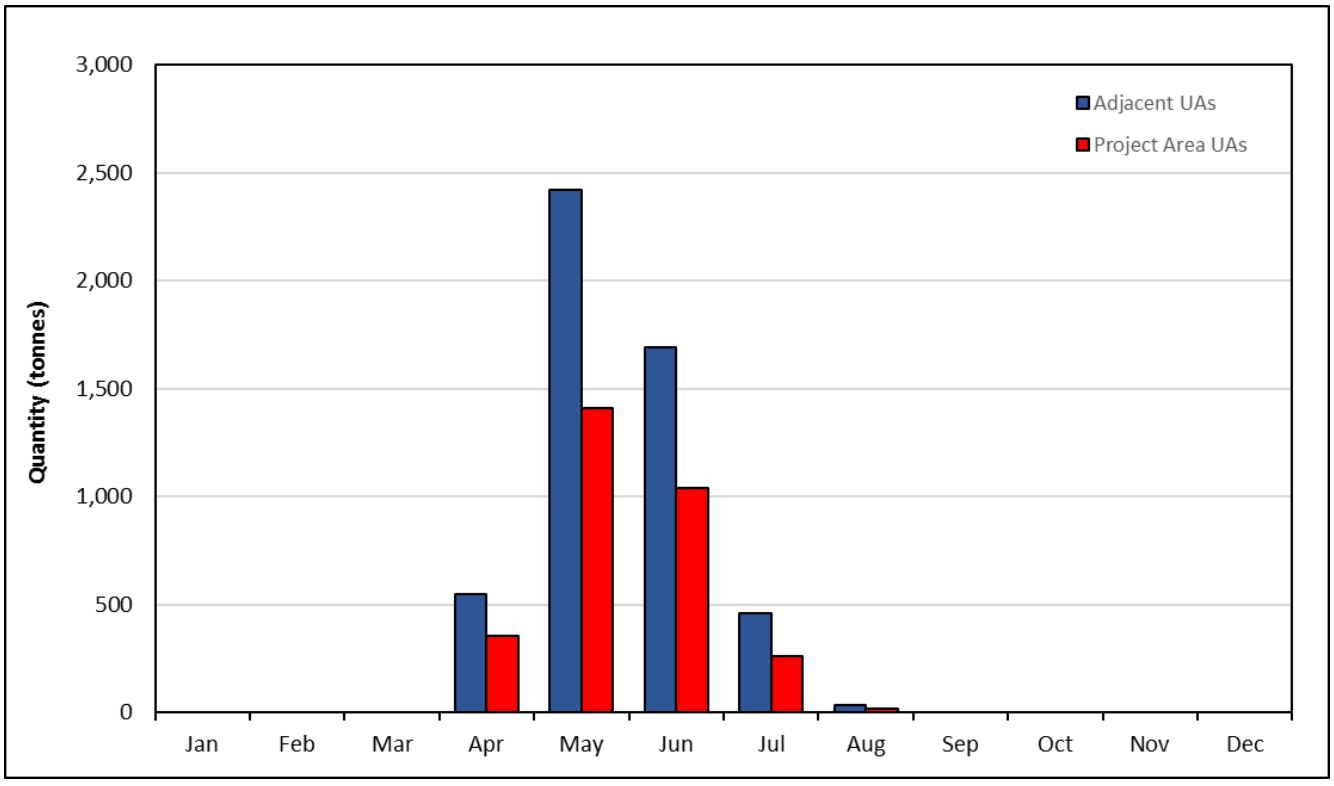
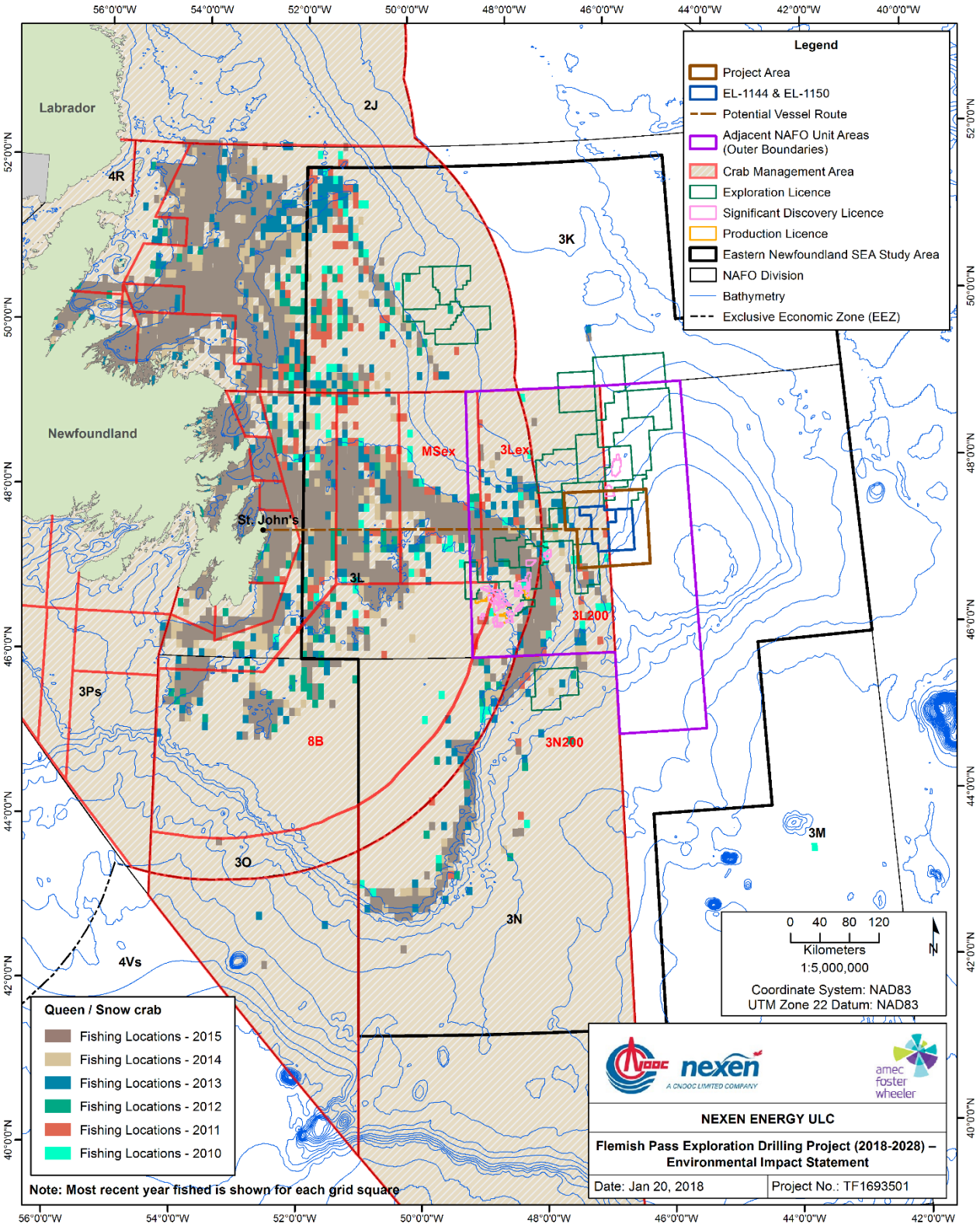


Figure 7.43 Harvesting Locations Snow Crab, All Months 2010-2015



Northern Shrimp

Until 2013/2014, the Northern shrimp (*Pandalus borealis*) fishery had been one of the most important commercial species harvests in the Eastern Newfoundland offshore, as it continues to be in more northern fishing areas off Labrador. Beginning in 2009, however, Division 3L (Shrimp Fishing Area 7) quotas were drastically reduced on an annual basis, from more than 20,000 tonnes that year to 5,085 tonnes in 2012 and just 1,415 tonnes in 2014, the last year that shrimp fishing was permitted in the area (DFO 2009, 2012, 2014a; Parrill 2016). In a recent report, DFO (2016b) states, "Departmental scientific advice indicates the size of the Northern shrimp biomass has been trending downwards as much as 70 percent to 90 percent over the last 6-7 years. Decreases are greatest at the southern end of the range off of Newfoundland and Labrador where the inshore fleet has access". Adjacent stocks on the Flemish Cap have been under NAFO moratorium since 2011 (NAFO 2016a). It is possible that some level of shrimp harvesting in Division 3L and/or 3M might be reinstated within the temporal scope of this EA, however.

The harvest was directed primarily towards Northern shrimp, while other species (particularly striped shrimp, *Pandalus montagui*) were also taken in smaller quantities. Harvesting in offshore areas has been conducted using dedicated shrimp trawls (stern otter-type or beam), towed at or near the sea floor, and typically extending more than 300 m behind the ship (DFA 2001). The tow duration is dependent on the catch rate; if it is high then the tow duration is less. The offshore ships typically try to maintain a fill level in the net for maximum quality. For the larger ships, tows can be typically about three hours, travelling at speeds of 3-4 knots, depending on the processing rate of the on-board facilities (R. Ellis, pers comm 2014).

Conservation measures include minimum trawl mesh sizes, by-catch minimizing devices and monitoring by fisheries observers. Otter and beam trawls utilize a minimum mesh size of 40 mm and are required to have a Nordmore Grate to minimize by-catch of groundfish and other shellfish. The fishery is monitored by at-sea observers that supervise the vessel for by-catch, gear restrictions, and closed time provisions (DFO 2010c).

Figure 7.44 shows the annual northern shrimp harvest within the Project Area UAs and Adjacent UAs for 2010-2015, and Figure 7.45 indicates the timing of the harvest over this period, for quantities by month of harvest. Figure 7.46 shows aggregated harvesting locations during those years.

Figure 7.44 Northern Shrimp, Project Area UAs and Adjacent UAs Quantity of Harvest by Year, 2010-2015

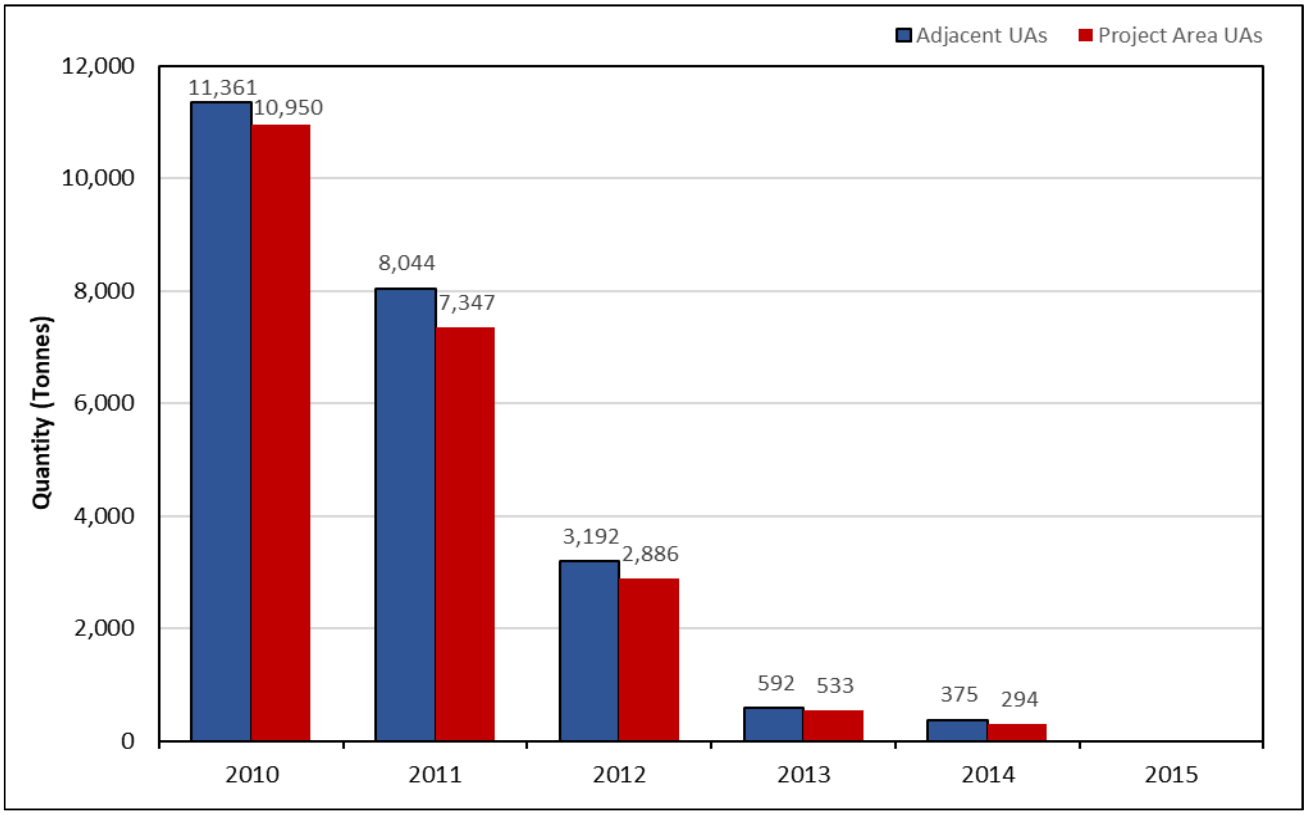


Figure 7.45 Northern Shrimp, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average

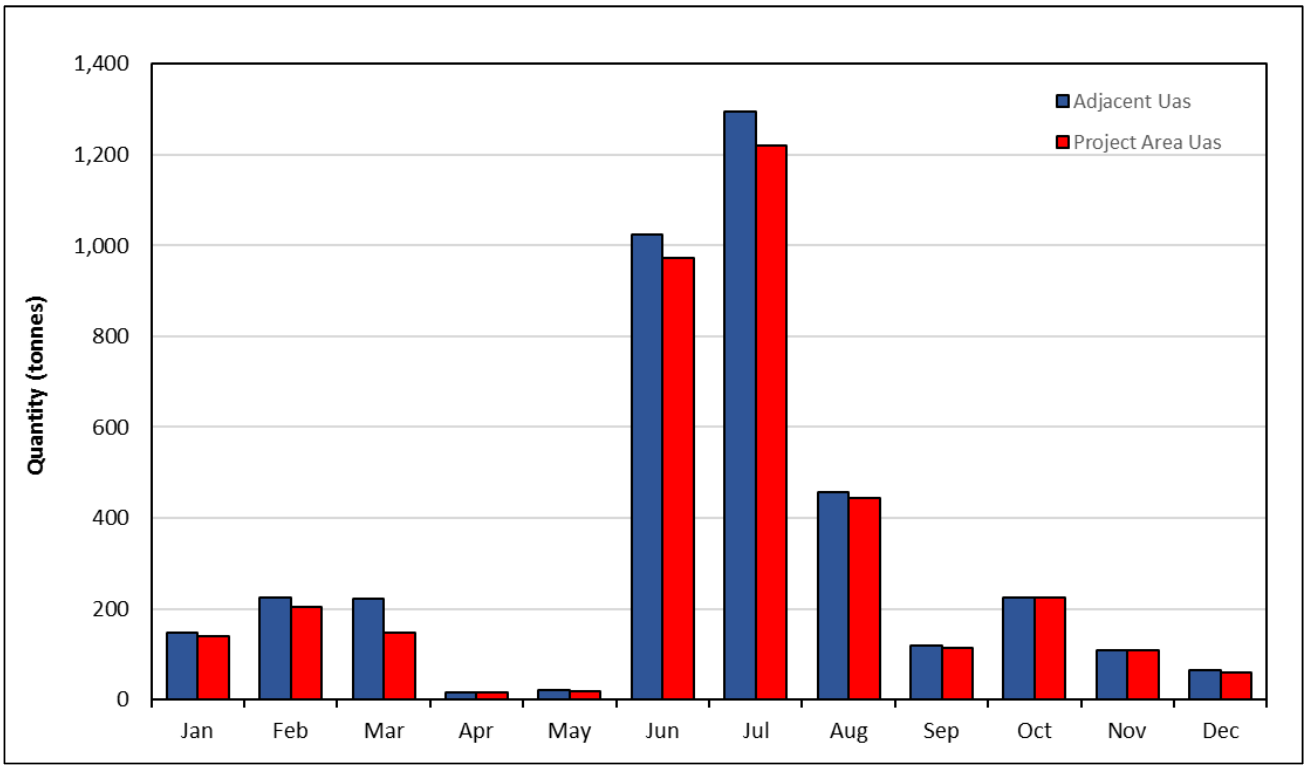
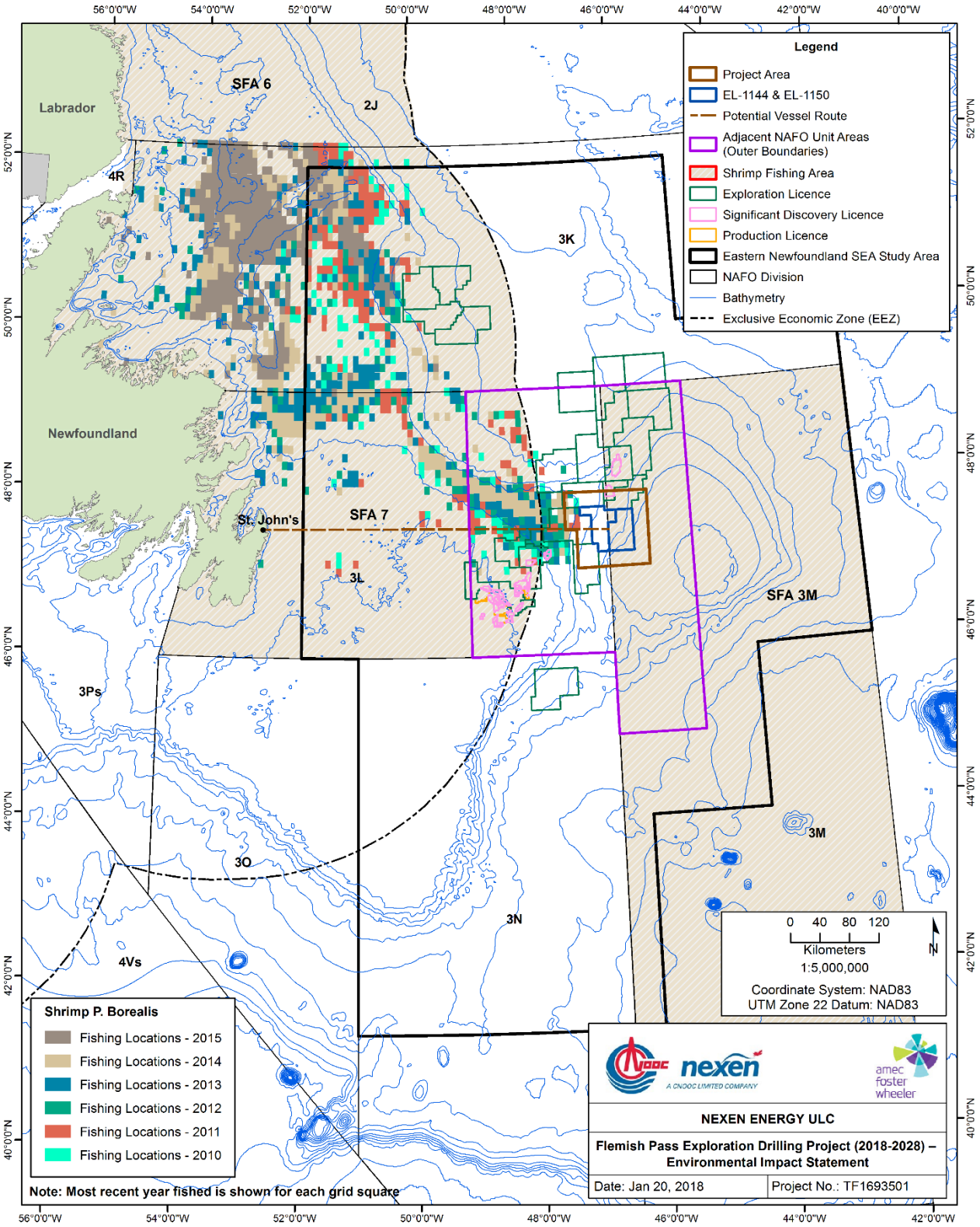


Figure 7.46 Harvesting Locations Northern Shrimp, All Months 2010-2015



Groundfish

This section provides additional information about domestic groundfish fisheries that are likely to continue to occur within the Adjacent UAs and possibly the Project Area during the temporal scope of this assessment. This section then presents additional details about the three key species (redfish, turbot/Greenland halibut and Atlantic cod) that are the most important groundfish by quantity of harvest (based on the DFO datasets), ranging from 2.9 percent (redfish) to 0.3 percent (Atlantic cod) of the total Adjacent UAs domestic harvest between 2010 and 2015. Together, these and all other groundfish species typically make up about five percent of the Adjacent UAs harvest by quantity and three percent by value (Table 7.14) in recent years, and much less in the Project Area UAs, although until the 1990s they constituted nearly 100 percent of the catch in both areas.

Groundfish harvesting in this part of the Grand Banks is managed partly by DFO and partly by NAFO, which also manages these species fisheries by foreign nations (see Section 7.2.9). The data referenced in this section is for Canadian domestic harvesting, though harvesting seasons and methods are similar for all participants. For most groundfish species (with the exception of Greenland and Atlantic halibuts), the predominant gear used is mobile trawl and many are harvested together either in directed fisheries or as limited by-catch harvests for those fisheries under continuing moratorium or where set quotas have been reached. The 2016 quotas and status of these fisheries are shown in Table 7.14.

Table 7.14 Status and 2016 Quotas for Key Groundfish Species

Groundfish Species	Area	Status	2016 Quota (tonnes)
Redfish	3LMN	Directed fishery	4,930
Turbot/Greenland halibut	3LMNO	Directed fishery	1,644
Atlantic Cod	3LMN	Moratorium (by-catch only), except 3M	111
Source: DFLR (2017); NAFO (2016b); D. Kulka, pers comm (2017)			

Harvesting is mainly with mobile gear, almost exclusively stern otter trawl, most towed behind large ships. Of the fixed gear fisheries, most are set gillnets (mainly turbot/Greenland halibut) with the remainder being longlines (mainly for Atlantic halibut).

The following graphs show the recent substantial variations in reported landings by year for the Project Area UAs and the Adjacent UAs (Figures 7.47 to 7.48) and then the same information for the three key groundfish species (Figure 7.49). Note again that owing to data redaction the 2014 and 2015 annual landing figures, particularly, are not complete for many species. Average monthly groundfish catches, all species, based on the DFO-supplied data are presented in Figure 7.48. As the monthly graph indicates, some groundfish harvesting occurs in the Adjacent UAs in most months, though the greatest concentrations have been in June and November-December when 75 percent of the harvest was taken.

Figure 7.47 Groundfish, Project Area UAs and Adjacent UAs Quantity of Harvest by Year, 2010-2015

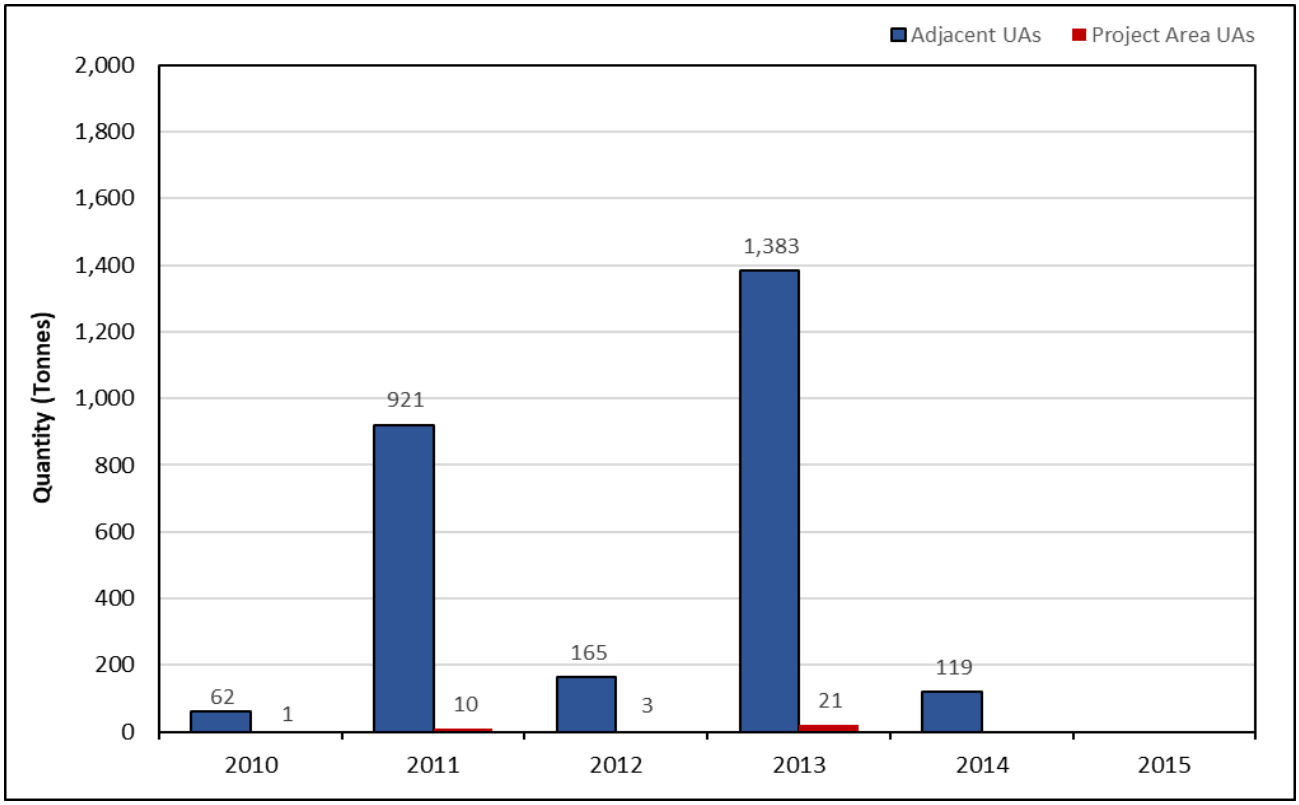


Figure 7.48 Groundfish, Project Area UAs and Adjacent UAs Quantity of Harvest by Month, 2010-2015 Average

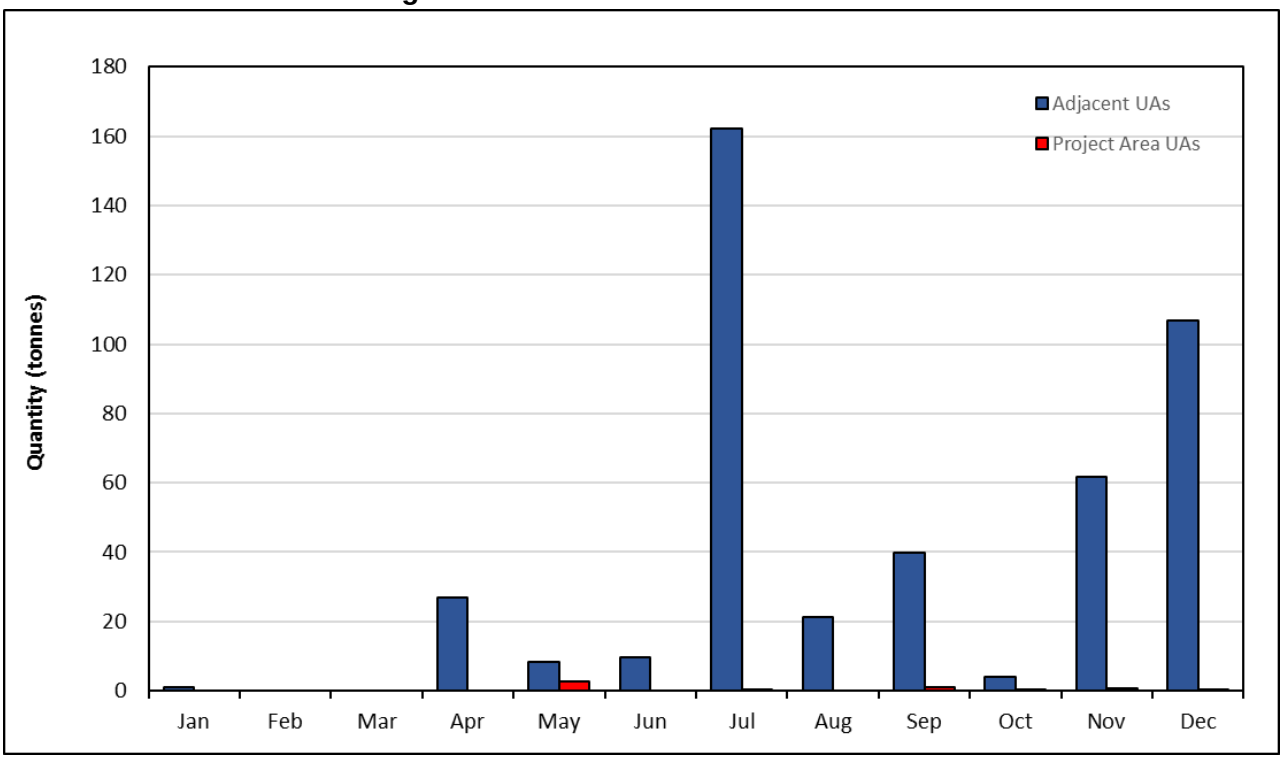


Figure 7.49 Key Groundfish Species, Adjacent Unit Areas Quantity of Harvest by Year, 2010-2015

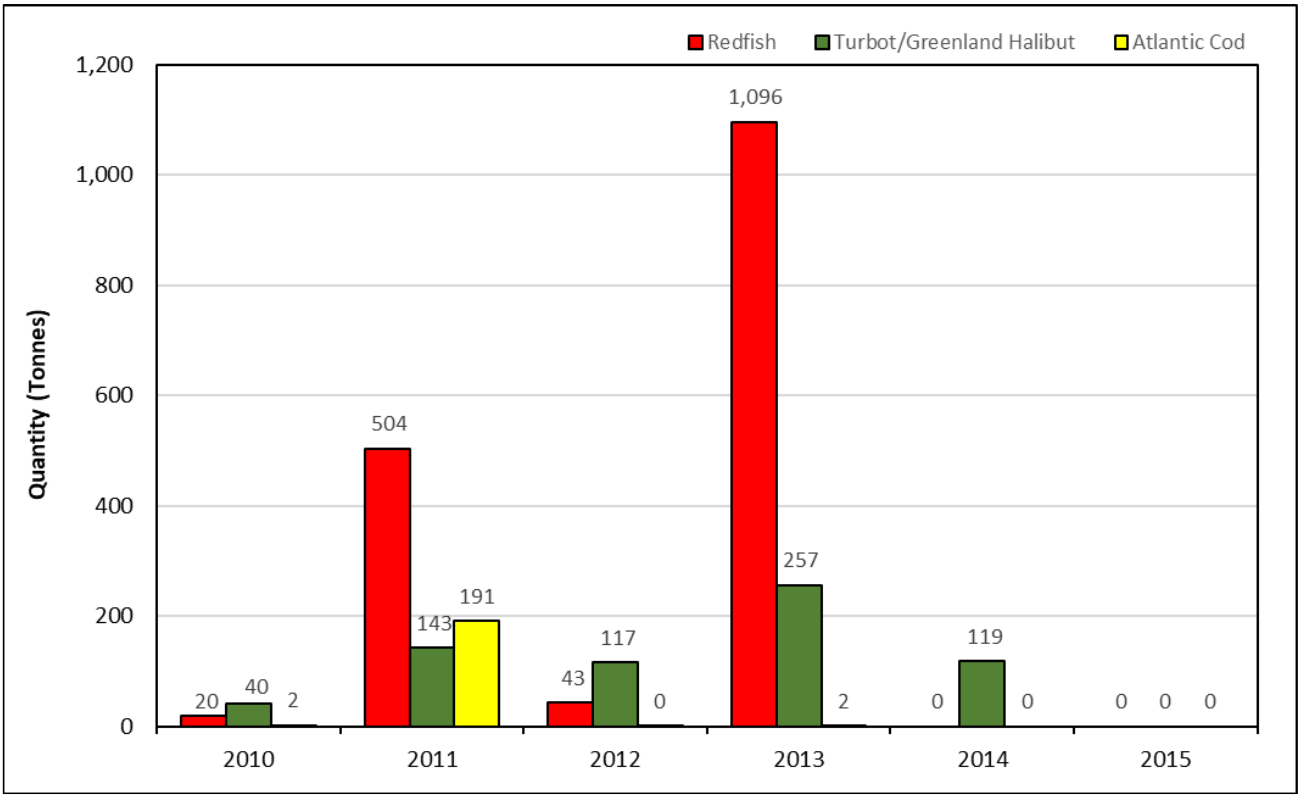
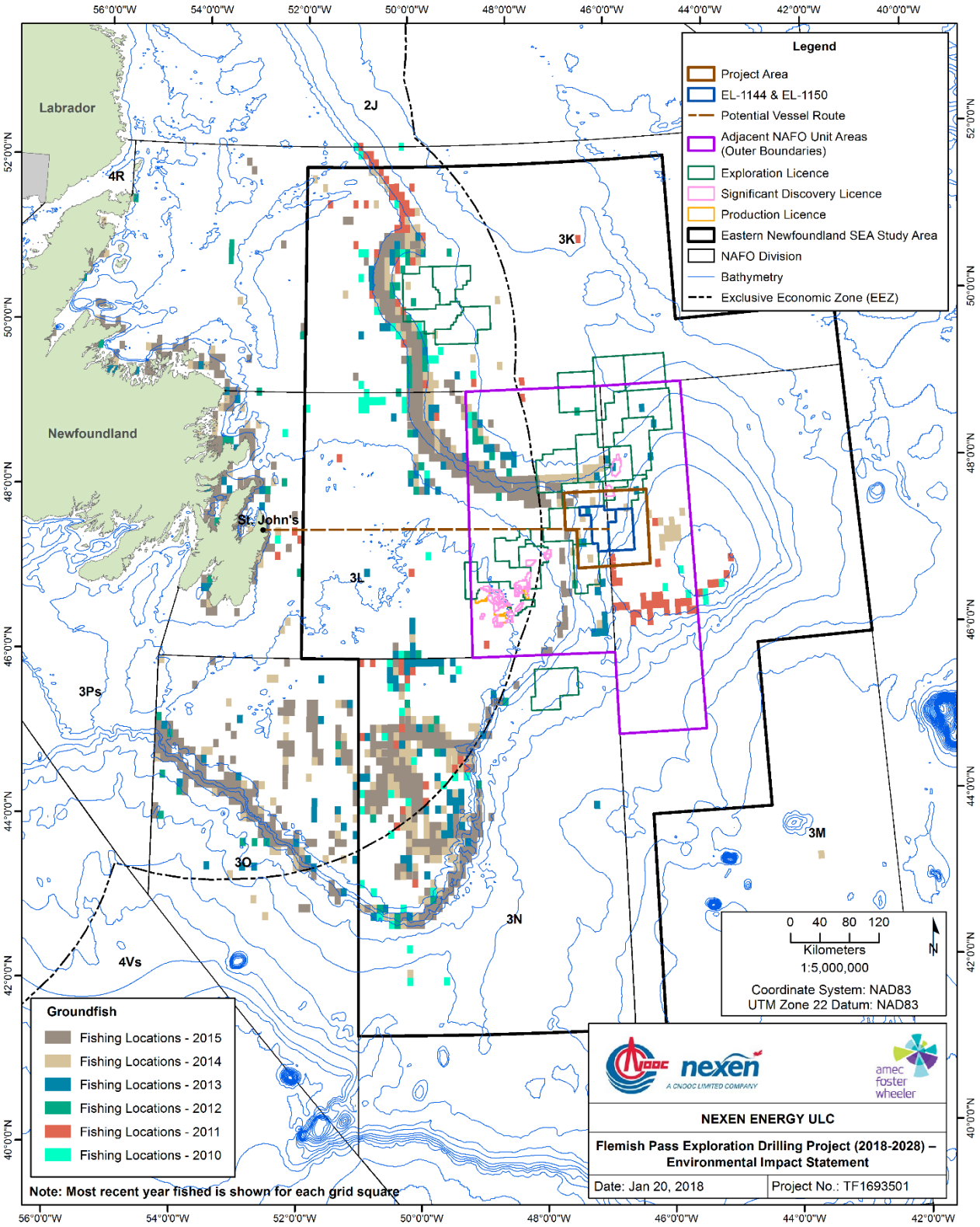


Figure 7.50 Harvesting Locations All Groundfish Species, 2010-2015



Redfish

There are three redfish (also known as ocean perch) species in the North Atlantic - *Sebastes fasciatus* (Acadian redfish), *S. mentella* (deepwater redfish) and *S. marinus* (golden redfish) - but catches are recorded together because of difficulties with identification and separation and are reported collectively as “redfish” in the fisheries data. The directed fishery for redfish in Divisions 3L was under moratorium from 1998 to 2009 but began again with a small quota (TAC) in 2010, which has increased substantially since then (NAFO 2016b; Parrill 2016).It is now the most productive groundfish fishery reported in the Adjacent UAs, accounting for 63 percent of the groundfish harvest by quantity and 45 percent by value, 2010-2015 (2.9 and 1.4 percent over all species), and the second most productive in the Project Area UAs (28 percent and six percent of the groundfish catch; 0.02 percent and 0.01 percent overall). The fishery is managed using TACs, minimum fish sizes, dockside monitoring, at-sea observer coverage and by-catch protocols. There are also closure periods in place to protect migration, redfish fertilization and larval extrusion periods (DFO 2016d; Goetting 2010).

Although a directed fishery, some redfish are also taken as by-catch in other directed fisheries (such as turbot), and both cod and turbot are taken as redfish by-catch (NAFO 2016c). Virtually all the redfish are harvested with bottom otter trawls in both areas, with less than one percent reported from gillnet by-catches. The harvest may occur year-round with most (97 percent for the Adjacent UAs) taken between June and December, based on the 2010-2015 DFO data. As the map in Figure 7.51 shows, the species are harvested along and near the shelf edge, and around the Flemish Cap.

Turbot/Greenland Halibut

The domestic turbot (Greenland halibut) fishery made up approximately 25 percent of the total quantity and 42 percent of the total value of groundfish landings in the Adjacent UAs and 62 percent (quantity) and 91 percent (value) in the Project Area UAs (2011-2015) (or, 1.2 and 1.3 percent, and 0.05 and 0.1 percent of all species catches, respectively). Like redfish, turbot is a directed quota fishery but, unlike redfish, most (89 percent in the Adjacent UAs) is caught using fixed gear gillnets, with the remainder taken in stern trawls. The directed turbot fishery also harvests restricted amounts of Atlantic cod and other groundfish by-catch, and is also taken as by-catch in other directed fisheries (NAFO 2016c).

Fixed gillnets are weighted to the sea floor at the bottom of the nets and held up in the water column by a series of floats attached to a headline and operate by entangling the fish as they attempt to swim through. The nets are often deployed in series (fleets), and are marked by surface buoys, which present some potential for contact with other marine activities if coincident in the harvesting area.

As the map in Figure 7.52 indicates, Project Area UA harvesting (both gillnets and bottom otter trawls) is concentrated on outer margins and slopes of the Grand Banks, stretching through the Adjacent UAs from south to north, but with a greater concentration in the north. The mobile stern otter trawl harvests tend to be by larger vessels (over 30 m) with the gillnet fishery generally using smaller boats (less than 20 m) (Brodie et al 2009). During the 2010-2015 period 92 percent of the Adjacent UA catch was taken during July and August.

As the map in Figure 7.52 shows, turbot is harvested in similar areas as redfish, along and near the shelf edge, and around the Flemish Cap.

Figure 7.51 Harvesting Locations Redfish, 2010-2015

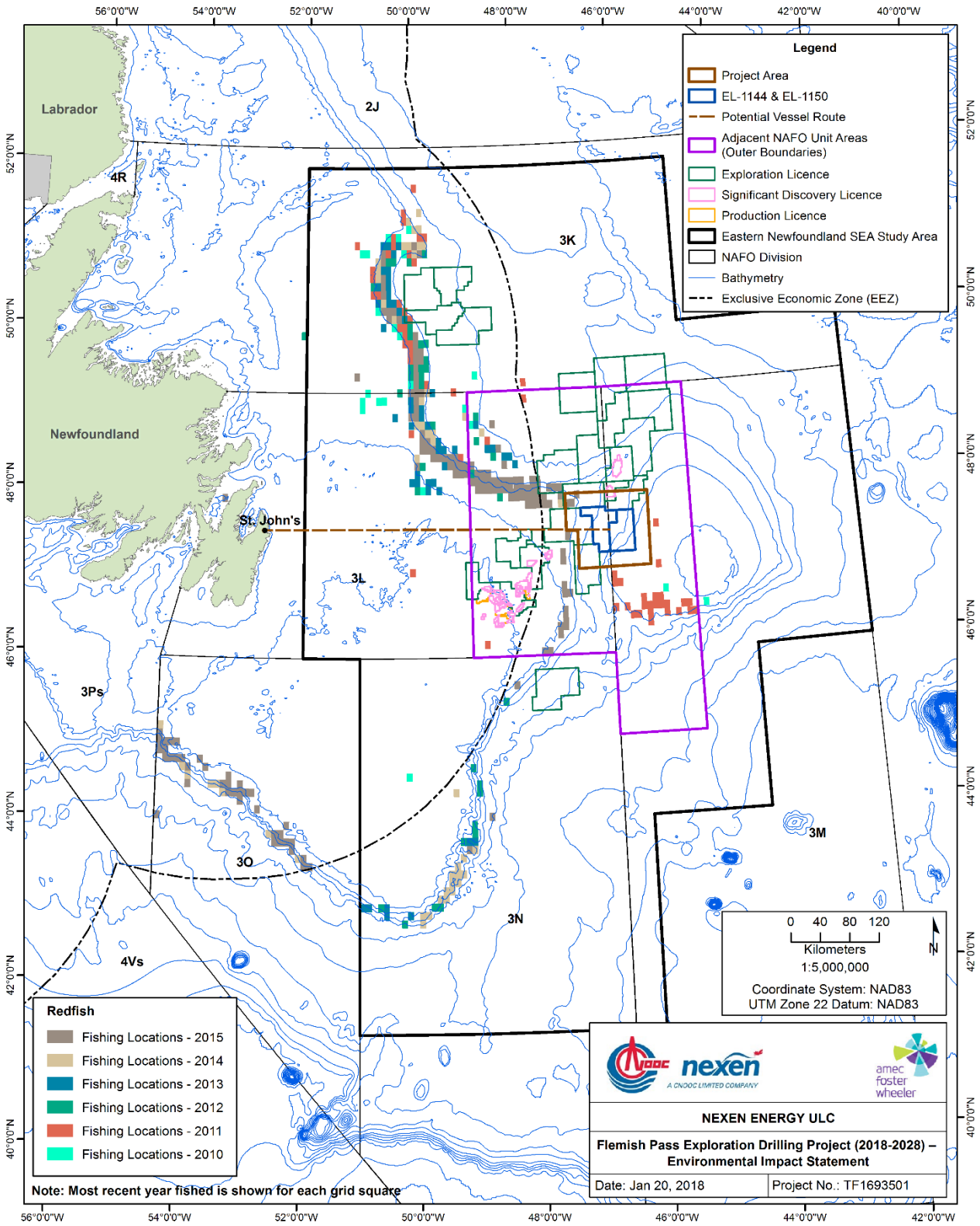
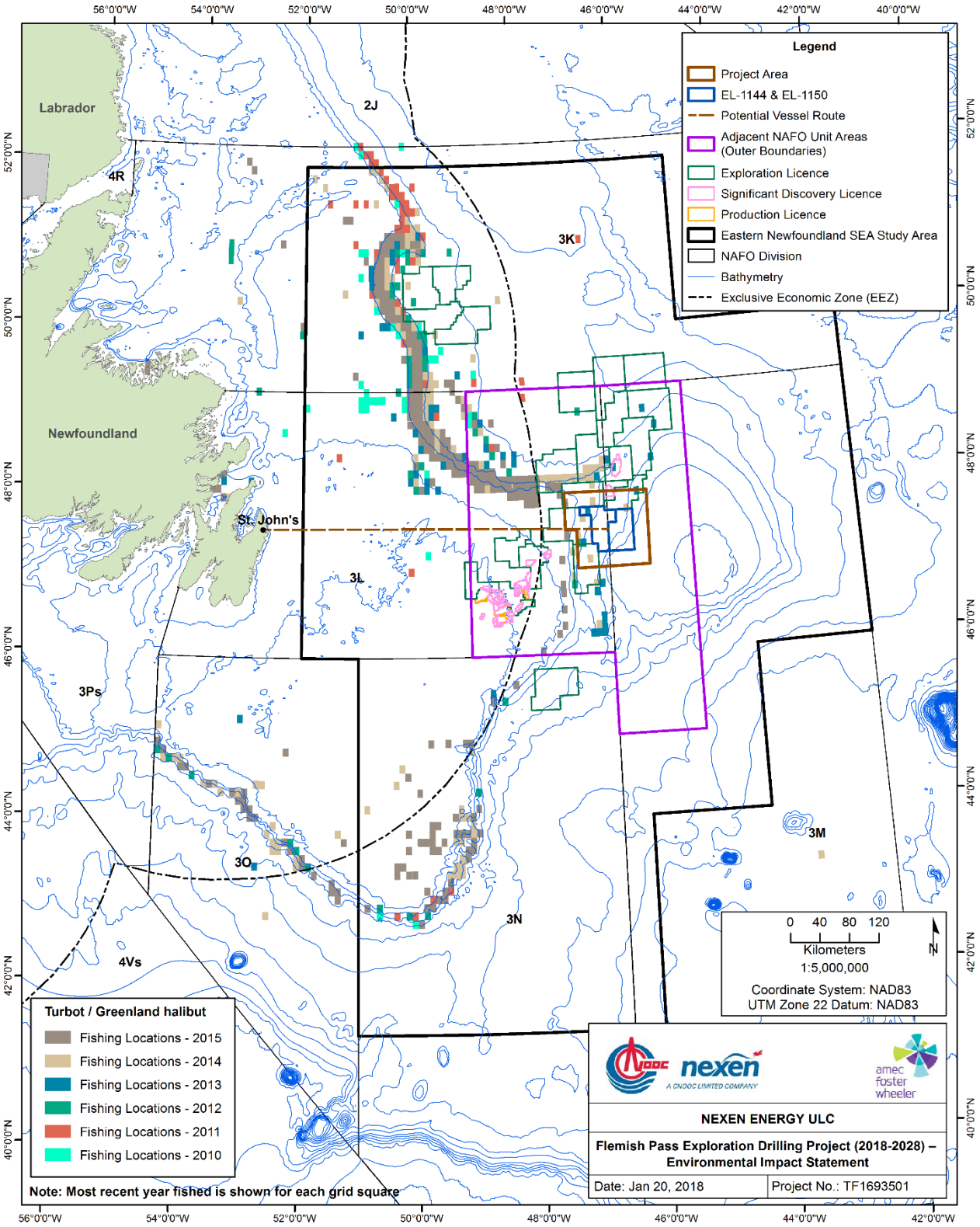


Figure 7.52 Harvesting Locations Turbot/Greenland Halibut, 2010-2015



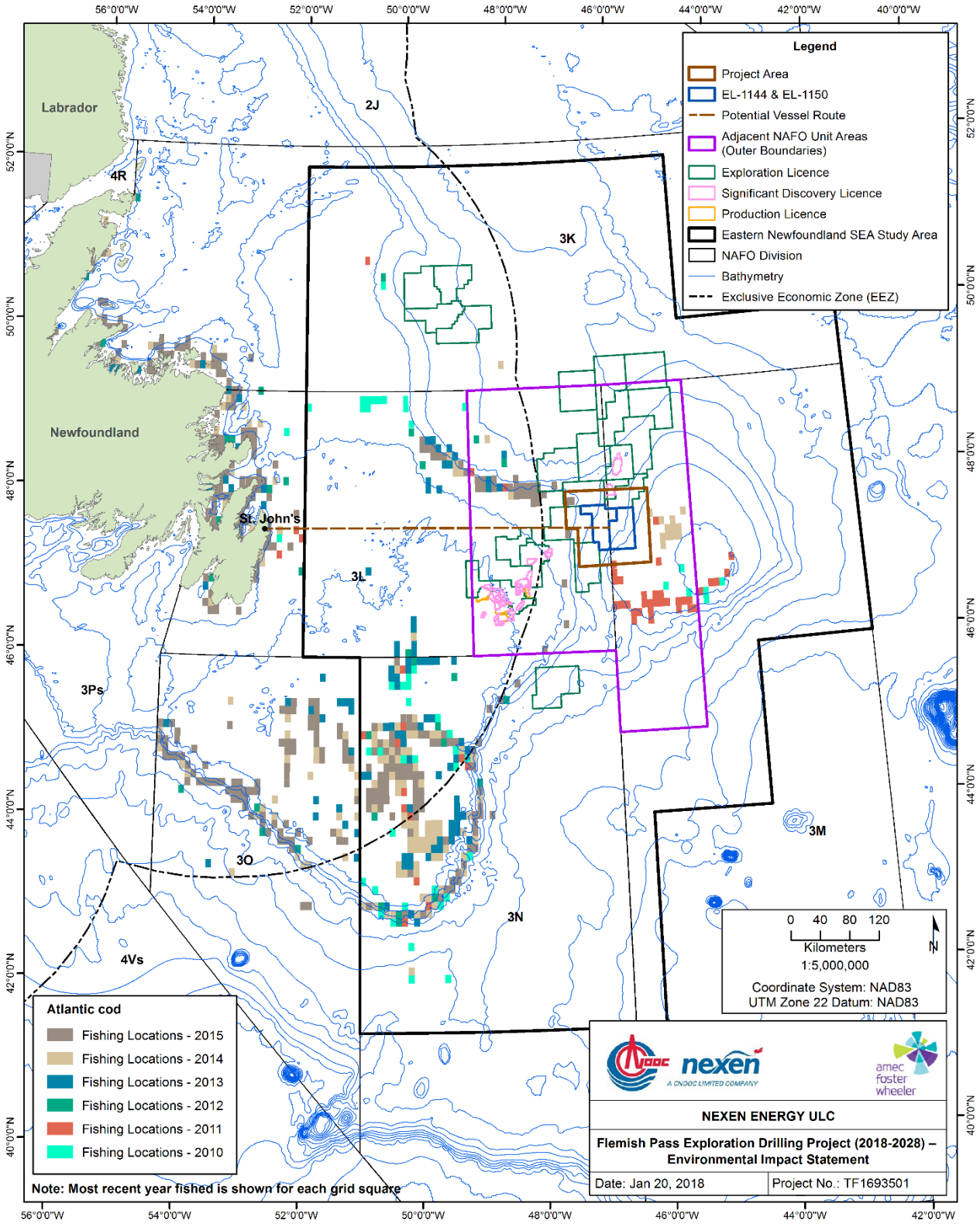
Atlantic Cod

Once the most important fishery (of all species) in the Grand Banks and northwest Atlantic, the cod fishery has been limited to by-catch landings since the 1990s, although a small directed Canadian commercial fishery was reinstituted in Division 3M (on the Flemish Cap) in 2010 (NAFO 2016d). Based on the 2010-2015 data, Atlantic cod made up seven percent of the groundfish catch by quantity and three percent by value, or 0.2 and 0.1 percent of the all-species fisheries within the Adjacent UAs and a negligible amount in the Project Area UAs. By-catches may occur in the redfish, turbot fisheries and other directed fisheries. In terms of gear, the harvest data show that the cod catch was entirely by mobile stern otter trawls.

Although recent surveys have suggested that some of the moratorium stocks may be recovering, the latest 2J3KL cod stock assessment recommended no lifting of the existing closures in the Project Area. It states, “The stock has increased considerably over the past decade, but remains within the critical zone,” and concluded that “At current levels of SSB [spawning stock biomass] the stock is considered to have suffered serious harm and the ability to produce good recruitment is seriously impaired. When the stock is at such a low level management actions should focus on promoting increases in SSB until the stock is more resilient to the effects of fishing” (DFO 2016e).

As with other primarily by-catch fisheries, Atlantic cod harvesting occurs in similar locations to the directed fisheries (Figure 7.53), and at similar times, with some harvesting potentially occurring year round, though 82 percent of the recorded annual amount was taken during April in the 2010-2015 period (Adjacent UAs).

Figure 7.53 Harvesting Locations Atlantic Cod, 2010-2015



7.2.5 Indigenous Fisheries

Several Indigenous groups hold commercial fishing licences for NAFO Divisions that overlap with the Project Area. This includes licences that permit access to a variety of species and locations within NAFO Divisions 3KLMN (see preceding figures), as follows (D Ball, DFO, personal communication 2017):

- *Labrador Inuit (Nunatsiavut Government):* Inshore groundfish enterprises licensed to operate in 3KL, and seal licences in Seal Fishing Areas 4-33 (Atlantic-wide).

- *Labrador Innu (Innu Nation):* Mid-shore enterprise (65 to 100 feet) with a groundfish licence permitting access to a variety of areas (Atlantic-wide) including 3KLMN and an Area 6 (3K) shrimp licence; an inshore enterprise with a mobile gear and fixed gear groundfish licence for 3KL.

- *NunatuKavut Community Council*: Multiple inshore enterprises with access to 3KL groundfish; Area 6 (3K) shrimp licences; seal licences allowing access in Seal Fishing Areas 4-33 (Atlantic-wide).

- *Miawpukek First Nation*: Multiple enterprises and licences that give access to 3KL; tuna licences in 3LN; a seal licence for Seal Fishing Areas 4-33; a swordfish licence that includes 3KLMNO.

- *Qalipu Mi'kmaq First Nation Band*: An inshore enterprise with a groundfish licence for 3K; a shrimp licence for Area 6 (3K); pelagic fishery access (herring, mackerel, and capelin) which occurs close to shore in 3KL; a snow crab licence for Area 4 (3K).

- *Mi'kmaq Alsumk Mowimsikik Koqoey Association (MAMKA)*: (formed by Miawpukek First Nation and Qalipu Mi'kmaq First Nation Band) an enterprise with a groundfish licence in 3KL.

In addition to Newfoundland and Labrador based Indigenous fisheries, several First Nations communities and councils in the DFO Maritimes and Gulf Regions hold communal licences which permit access to NAFO Subarea 3 fisheries (eg, for swordfish), as described in Section 7.4.

During Nexen's engagement with Indigenous groups as part of the development of this EIS (Chapter 3), none of the groups indicated that they hold, claim or otherwise assert Aboriginal or Treaty rights within or near the Project Area, pursuant to Section 35 of the *Constitution Act*, 1982. Rather, Nexen understands that these communities or councils undertake fishing activity off Eastern Newfoundland through commercial licences issued by the federal government under the *Fisheries Act* and its associated *Aboriginal Communal Fisheries Licencing Regulation*, as well as other government policies and strategies that are designed to involve Indigenous people and communities in commercial fisheries in Canada. There is no documented food, social, or ceremonial fishing within or near the Project Area.

7.2.6 Regional Commercial (Domestic) Fisheries

Sections 4.3.1 and 13.1 define the RSA for fisheries and other ocean uses, which includes NAFO Divisions 3K, 3L, 3M, 3N and 3O (collectively 3KLMNO; see Figure 7.5). This is a marine area of approximately 1,360,000 km^2, ranging from the coastal waters of the Island of Newfoundland to as far as 1,200 km from shore. As noted in Section 13.1, the RSA is used for describing and understanding fisheries and other activities in the larger region surrounding the Project Area, and to provide regional context to the environmental effects analysis (Chapter 13).

7.2.6.1 Harvest Composition and Values

The history and current make up of much of the 3KLMNO fisheries are similar to the Project Area and Adjacent Unit Areas fisheries (as described in Sections 7.2.3 and 7.2.4). Since the closures of the Newfoundland and Labrador groundfisheries, harvests have been predominantly shellfish, mainly Northern shrimp and snow crab, but with an important component of lobster from the inshore waters of 3K and 3L. Offshore Northern shrimp harvesting on the eastern Grand Banks was halted by 2015. Within Divisions 3KLMNO the only such shrimp fishery active in 2017 occurred in Division 3K (SFA 6), although in May 2017 it was announced that the 2017-2018 Northern shrimp TAC for SFA 6 would be reduced by 62.6 percent to 10,400 t (DFO 2017a).

Table 7.15 provides average recorded catch quantities and values of domestic commercial catches from Divisions 3KLMNO for 2010 to 2015, based on the previously described DFO datasets. As described above in Section 7.2.2, these data have been redacted by DFO for confidentiality reasons, so quantities and values may be substantially lower for some species. In particular, the amounts shown for deep-sea clams - mainly Arctic/Stimpson's surf clams (*Mactromeris polynyma*), which are harvested using mobile hydraulic dredges, underrepresent the importance of this fishery. For 2015, Clearwater Seafoods Limited Partnership, which holds the three Atlantic Canada licences for this fishery, reported clam sales of $84.4 million from harvests on both the Newfoundland Grand Banks (within 3N and 3L) and the eastern Scotian Shelf. With the addition of a new ship for the Newfoundland area in 2015, Clearwater expected to increase sales by 50 percent (Clearwater 2016a; 2016b). However, in September 2017, DFO announced that intended to issue a fourth licence for the region, so that the participants and total catches may change in 2018 (DFO 2017b).

Table 7.15 NAFO Divisions 3KLMNO by Quantity and Value of Domestic Harvest, All Species 2010-2015 Averages

Species	2010-15 Average Quantity (tonnes)	2010-15 Average Value ($)	Percent of Total Quantity	Percent of Total Value
Northern Shrimp	42,808	89,313,551	35.94%	30.06%
Queen/Snow Crab	41,436	186,072,712	34.79%	62.63%
Capelin	21,116	4,774,988	17.73%	1.61%
Atlantic Cod	3,459	3,811,558	2.90%	1.28%
Mackerel	2,136	949,052	1.79%	0.32%
Atlantic Herring	1,960	528,901	1.65%	0.18%
Turbot/Greenland Halibut	2,190	6,660,951	1.84%	2.24%
Yellowtail Flounder	1,345	359,127	1.13%	0.12%
Herring	499	98,877	0.42%	0.03%

Species	2010-15 Average Quantity (tonnes)	2010-15 Average Value ($)	Percent of Total Quantity	Percent of Total Value
Sea Urchins	292	509,475	0.24%	0.17%
American Plaice	196	70,539	0.16%	0.02%
Lobster	166	1,517,789	0.14%	0.51%
Seal Products	151	1,247,233	0.13%	0.42%
Cockles	115	136,447	0.10%	0.05%
Winter Flounder	81	43,234	0.07%	0.01%
Redfish	74	41,365	0.06%	0.01%
Groundfish Heads	70	107,219	0.06%	0.04%
Deep-Sea Clams	48	73,487	0.04%	0.02%
Atlantic Rock Crab	45	36,322	0.04%	0.01%
White Hake	32	9,074	0.03%	0.00%
Atlantic Halibut	30	169,379	0.03%	0.06%
Monkfish	29	31,171	0.02%	0.01%
Greysole-Witch Flounder	25	8,464	0.02%	0.00%
All Other	814	528,658	0.68%	0.18%
Totals	119,118	297,099,573	100.00%	100.00%

Table 7.16 provides the available domestic commercial fisheries catch data (quantity and value) by year from 2010 to 2015. As shown in the table and the following figures (Figure 7.54 and 7.55), while the overall quantity of the Divisions 3KLMNO harvest remained generally stable from 2011 to 2015, the value of the harvest in those years increased. This was owing to increasing prices paid to fishing enterprises for some species, particularly for snow crab, where the landed price per kilogram nearly doubled between 2010 and 2015.

Table 7.16 NAFO Divisions 3KLMNO Quantity and Value of Domestic Harvest by Year, All Species 2010-2015

Year	Quantity (tonnes)	Value ($)
2010	147,861	222,369,873
2011	111,636	298,289,659
2012	116,044	272,750,881
2013	115,838	262,963,967
2014	110,216	322,284,209
2015	113,113	403,938,850
Total	714,708	1,782,597,439
Average	119,118	297,099,573

Figure 7.54 NAFO Divisions 3KLMNO Quantity of Domestic Harvest by Year, 2010-2015

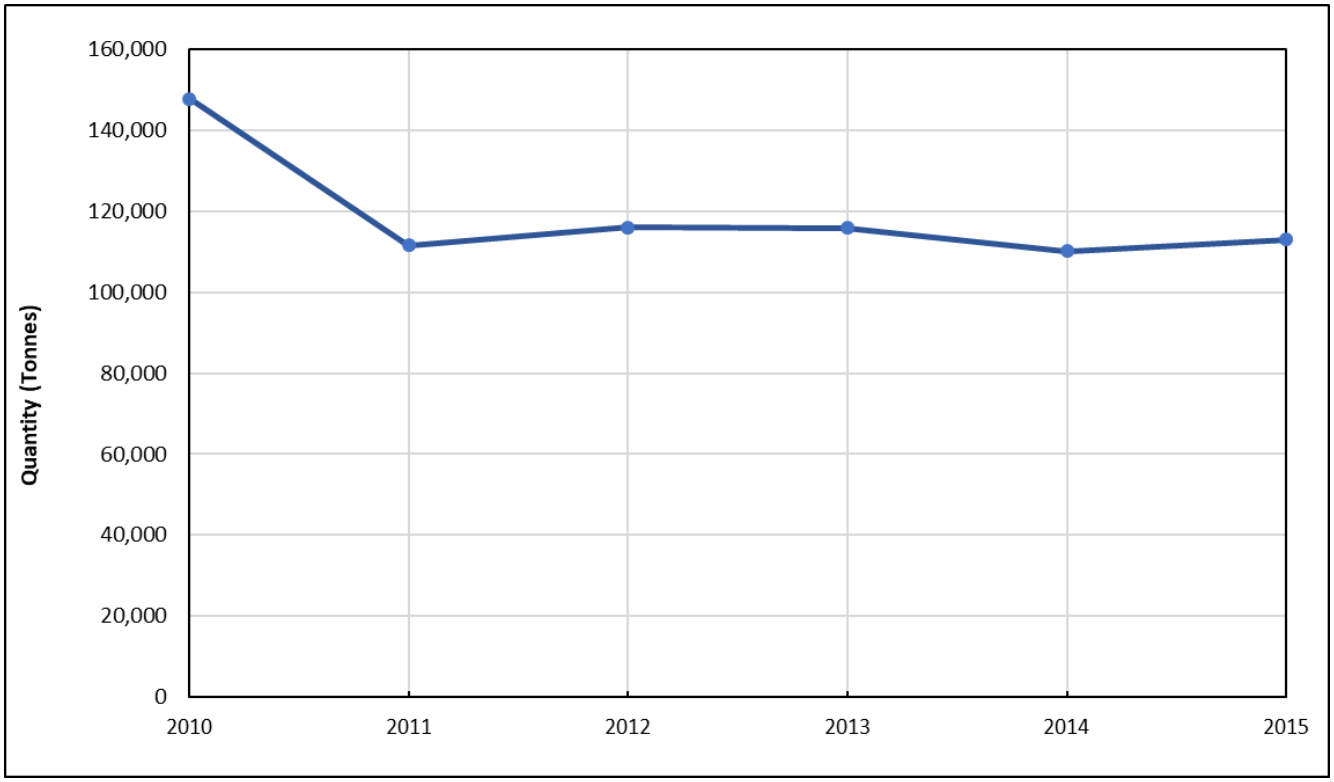
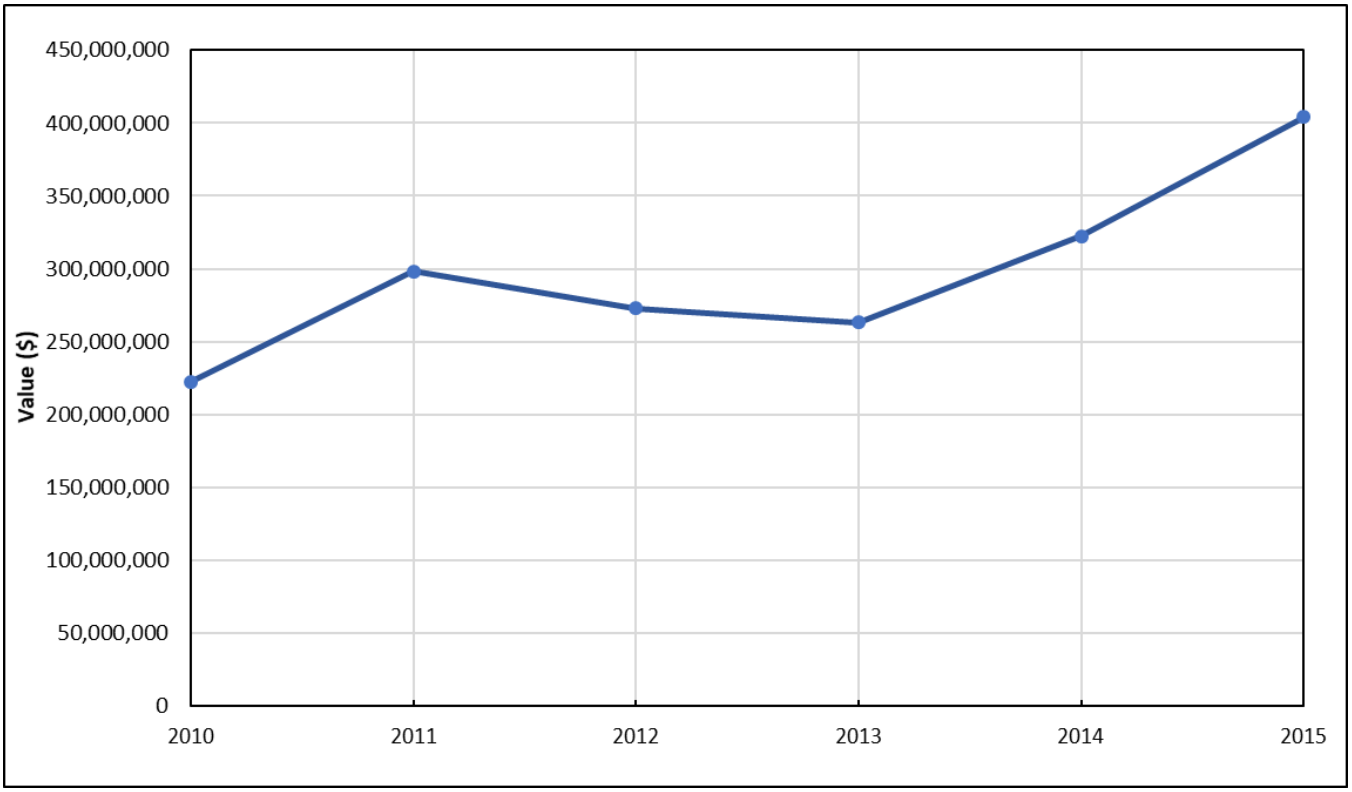


Figure 7.55 NAFO Divisions 3KLMNO Value of Domestic Harvest by Year, 2010-2015



7.2.6.2 Harvesting Locations

The series of maps in the preceding sections illustrate domestic commercial harvesting locations in the larger 3KLMNO area as well as within the Project Area and Adjacent Unit Areas. This includes information on fisheries by month, by gear type and for key species, based on available georeferenced fisheries data provided by DFO for 2010-2015. As those figures show, harvesting is widespread within Divisions 3KLMNO, over most of the Grand Banks, within the bays and other inshore waters, and northward through much of 3K, with some of the greatest concentrations of activity near the shelf margins. While most activities are within Canada's EEZ, notable exceptions are the "Nose" (eastern 3L) and the "Tail" (southern 3N) of the Banks. The Flemish Cap (in 3M) has also been an important area, especially for foreign fish harvesting.

Not reflected in the DFO data and thus shown on these maps are the locations for some inshore small-boat harvesting, most notably for lobster, since fishing locations are not usually recorded in the available datasets. Lobster harvesting, conducted using fixed-gear pots/traps, typically occurs within a few kilometres from shore and around coastal islands.

Figures 7.56 and 7.57, below, graph the relative quantities and values of the domestic commercial harvest from the 3KLMNO area by NAFO Division.

7.2.6.3 Fishing Gear

Table 7.17 shows the quantity and value of the harvest taken by fixed and mobile gear, and by the specific gear types active in 3KLMNO waters, based on the DFO domestic commercial fisheries data. As the data show, the two gear types that accounted for the largest part of the catch by both quantity and value were pots (snow crab and lobster) and shrimp trawl (71 percent of the area's harvest quantity and 93 percent of its value) for the 2010-2015 period. As discussed above, however, shrimp harvesting has been halted in most of the area, so that use of this gear will be much lower in future years.

The seining harvests (both fixed and mobile) in this area are primarily for capelin, which makes up a fairly high quantity of the Divisions 3KLMNO catch (17.7 percent, 2010-2015) but is of relatively low commercial value (1.6 percent of total value). Other gear types, such as bottom otter trawls, catch a variety of species, in both directed and by-catch fisheries, including redfish, turbot/Greenland halibut and Atlantic cod. As noted above, deep-sea clam dredging is significantly underrepresented in the datasets owing to data confidentiality.

The maps in Section 7.2.4.4 indicate recorded domestic harvesting locations by fixed gear (Figure 7.22) and by mobile gear (Figure 7.23) for all years 2010-2015, and by season for each type (Figures 7.24 - 7.25). Again, note that lobster harvesting locations are not given.

Figure 7.56 NAFO Divisions 3KLMNO Relative Quantity of Domestic Harvest by Division, 2010-2015

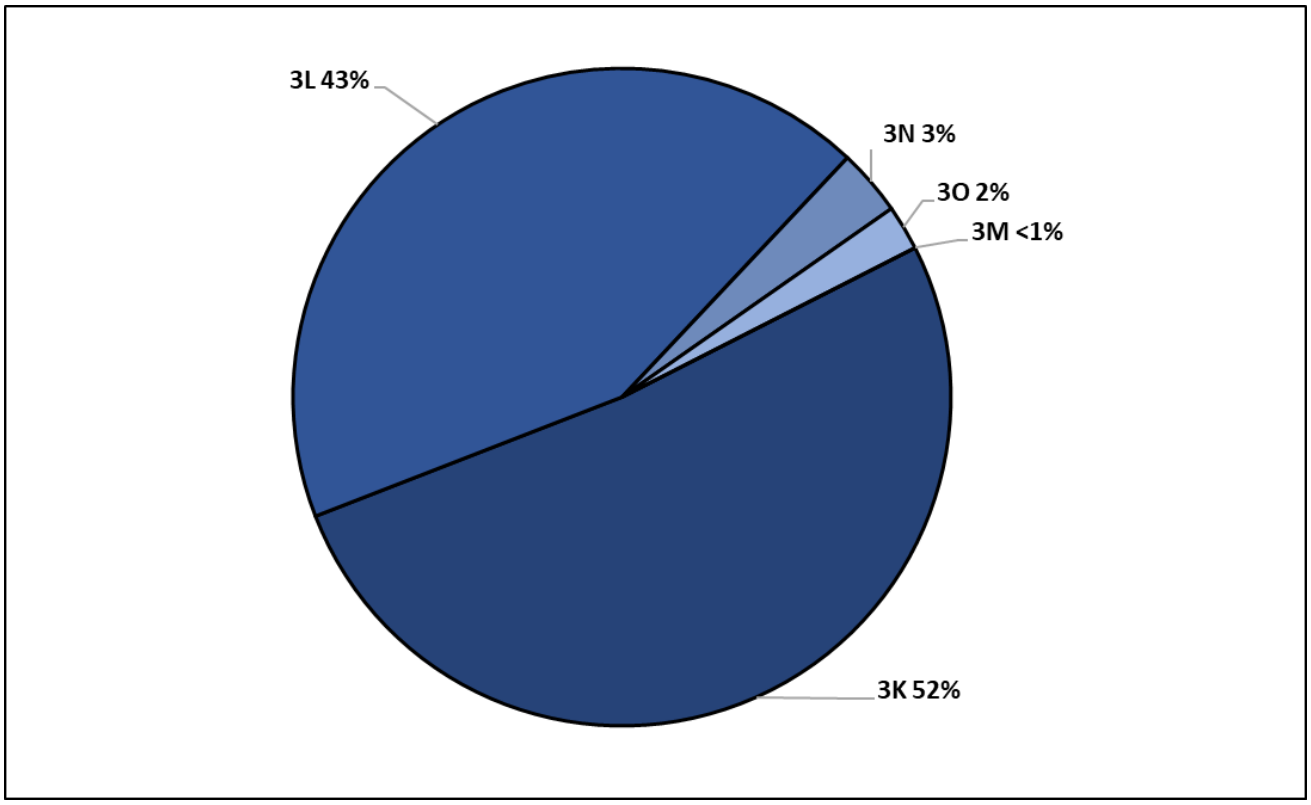


Figure 7.57 NAFO Division 3KLMN Relative Value of Domestic Harvest by Division 2010-2015

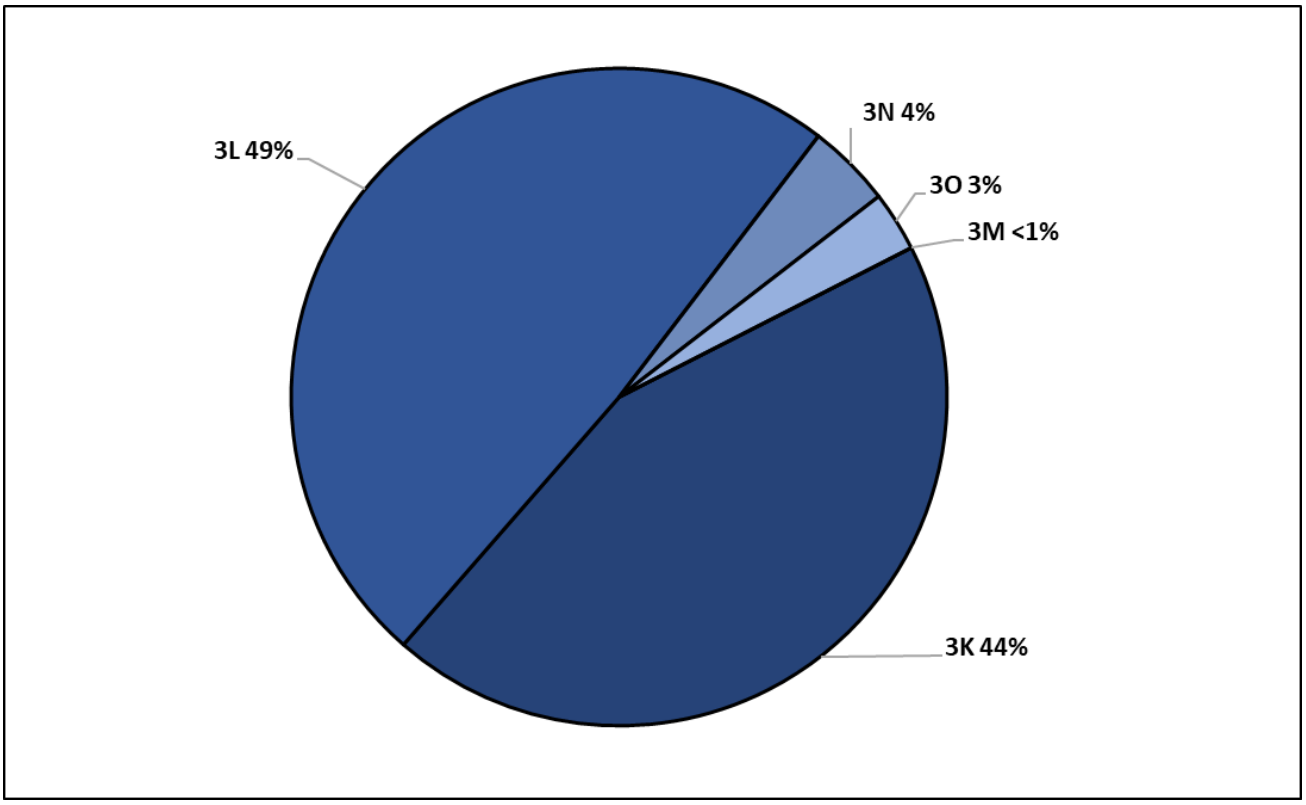


Table 7.17 NAFO Divisions 3KLMNO Quantity and Value of Domestic Harvest by Fishing Gear Type, 2010-2015 Averages

Fishing Gear	Average Quantity (t) 2010-2015	Average Value ($) 2010-2015	Average Percent of Total Gear Quantities	Average Percent of Total Gear Values
Fixed Gear				
Pot	42,075	187,716,228	35.32%	63.18%
Tuck Seine	9,652	2,239,110	8.10%	0.75%
Gillnet (set of fixed)	5,223	9,806,150	4.38%	3.30%
Trap Net	3,107	735,245	2.61%	0.25%
Beach and Bar Seine	1,777	447,810	1.49%	0.15%
Hand Line (Baited)	465	505,091	0.39%	0.17%
Longline	74	202,642	0.06%	0.07%
Mechanical Jigger	19	12,642	0.02%	0.00%
Fyke Net	14	75,790	0.01%	0.03%
Other Fixed	8	12,647	0.01%	0.00%
Total Fixed	62,414	201,753,354	52.40%	67.91%
Mobile Gear				
Shrimp Trawl	43,029	89,360,284	36.12%	30.08%
Purse Seine	11,154	2,912,385	9.36%	0.98%
Bottom Otter Trawl	1,913	1,105,365	1.61%	0.37%
Diving	292	509,475	0.24%	0.17%
Dredge (Boat)	165	211,475	0.14%	0.07%
Seal Hunting	151	1,247,235	0.13%	0.42%
Total Mobile	56,704	95,346,219	47.60%	32.09%
Total All Types	119,118	297,099,573	100.0%	100.0%

7.2.6.4 Seasonality

Although some fisheries in the area are open year-round, the harvesting of most species is focused within the period between spring and early fall, with more than 80 percent of the Divisions 3KLMNO harvest (by weight and value) being taken from May to August during 2010-2015. Timing depends on such factors as weather, management seasons, market conditions and individual fishing enterprise business plans. The more detailed information about the seasonality of key Adjacent Unit Area species described in Section 7.2.4.4 is also relevant for many Divisions 3KLMNO activities.

The following graphs (Figures 7.58 and 7.59) show the average reported domestic harvest quantity and value, all species, by month for the 2010-2015 period from within NAFO Divisions 3KLMNO. The previous maps show location of harvesting by month using georeferenced datasets.

Figure 7.58 NAFO Divisions 3KLMNO Quantity of Domestic Harvest by Month, 2010-2015 Average

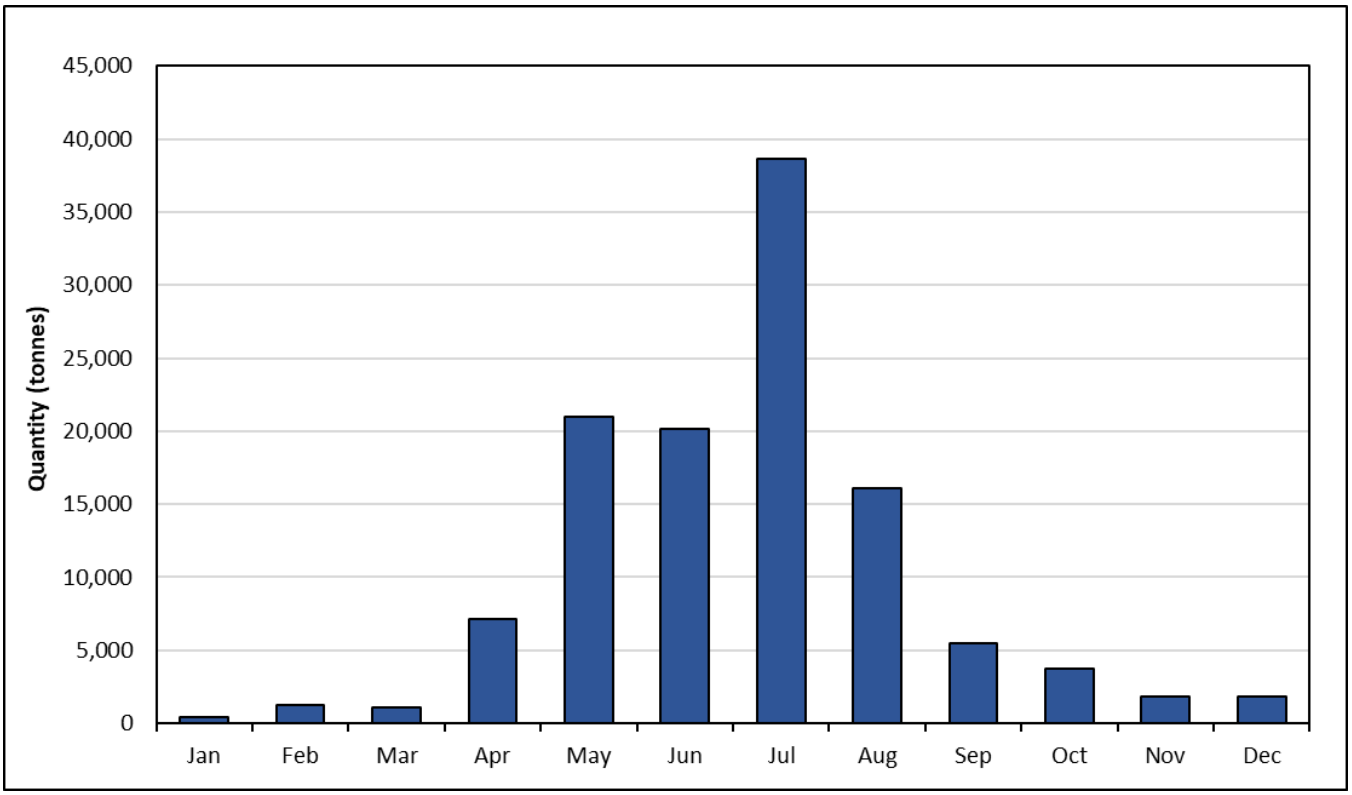
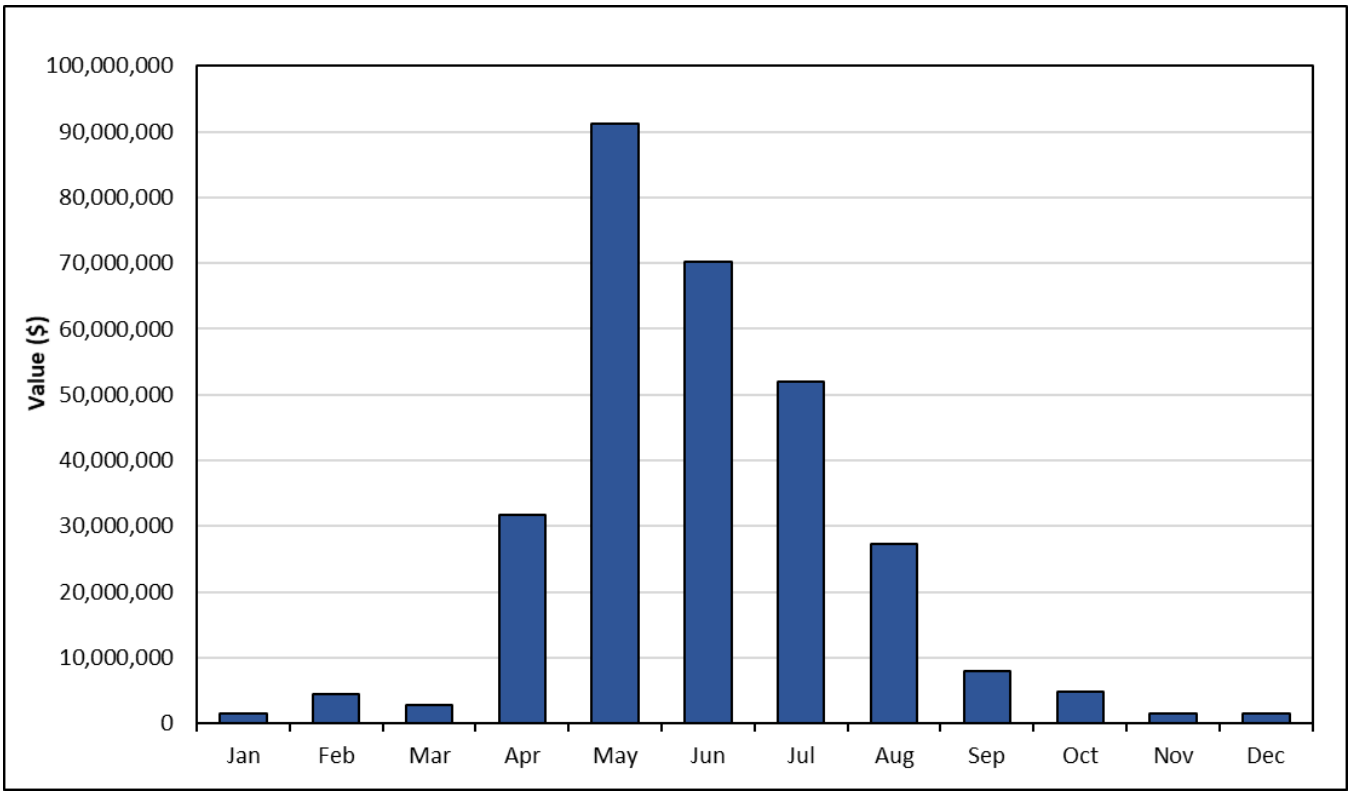


Figure 7.59 NAFO Divisions 3KLMNO Value of Domestic Harvest by Month, 2010-2015 Average



7.2.7 Recreational Fisheries

Recreational fishing takes place in both coastal and inland waters around the Island of Newfoundland and the coastal areas of Labrador, quite distant from the Project Area which is more than 400 km from the closest ports. A marine food fishery for groundfish has also been allowed in recent years for restricted periods during the summer and fall. Although such fishing is permitted in or near the Project Area, it is not likely to occur considering the non-commercial status of most participants and the great distances from shore. Both residents and non-residents are permitted to participate in recreational fishing without licences or tags. Open times may vary, as may other aspects of the fishery, which are announced each year. Table 7.18 shows key management requirements and restrictions for 2017. Commercial fishing and sale of catch from the recreational fishery are not permitted, and commercial vessels may not take commercial catches on a recreational/food fishing trip (DFO 2017c).

Table 7.18 Recreational Groundfish (Food) Fishery (2017)

Species	Season(s)	Restrictions	Individual Retention Limit	Boat Limit
Groundfish (with some fish prohibited)	Summer and Fall (see below)	Some locations prohibited; Only angling gear and handlines with a maximum of three hooks permitted. For safety, fishing is only permitted from 1 hour before sunrise until 1 hour after sunset.	5 groundfish (including cod) per fisher per day	15 groundfish when 3 or more persons are fishing in one boat. For 2017, tour boat operators can apply for a licence for an increased trip limit, with specific reporting requirements.
Source: DFO (2017c)				

The 2017 open dates (a total of 46 days) are

Summer Season:

- Saturday July 01, 2017 to Monday July 03, 2017
- Saturday July 8, 2017 to Sunday July 09, 2017
- Saturday, July 15, 2017 to Sunday, August 06, 2017,
- Saturday, August 12, 2017 to Sunday, August 13, 2017
- Saturday, August 19, 2017 to Sunday, August 20, 2017
- Saturday, August 26, 2017 to Sunday, August 27, 2017

Fall Season:

- Saturday, September 23, 2017 to Sunday, October 01, 2017

7.2.8 Potential Future Domestic Fisheries

Recent consultations related to Newfoundland and Labrador fisheries have noted that continuing changes within the marine environment are affecting the distribution and availability of several species. A recent example of these changes is the closure of the Northern shrimp fishery in Divisions 3L and 3M, and the increasingly fragile status of this species to the north. As the marine environment continues to warm, fishers expect that they will be able to fish more for groundfish, as in pre-moratorium times,

and many have kept their groundfish licences in anticipation of this trend in the future (Amec 2014). Similarly, extended warm water periods in the Project Area may increase the prevalence of high-value large pelagic species (swordfish and tunas). Fishers have therefore stated that it is important to consider not only what the fishery looks like now, but how it may be in the future, such as if a directed fishery for cod were to resume, there might be an increased use of mobile gear (Amec 2014). There is also some possibility that the Northern shrimp fishery might be reinstated during the temporal scope of this EA.

In terms of fish species that are currently considered to be underutilized and possible future fisheries in the Project Area UAs, identifying and evaluating this potential requires consideration of a wide range of factors, including biological (species presence, abundance, status) and socioeconomic (market demand and price, skills and equipment costs) considerations, as well as resource management and regulatory decisions. If a new fishery, or a currently closed fishery, should become active within the Project Area during the temporal scope of this EA, it will be identified in regular fishery information and analysis completed by Nexen as the Project progresses (see Chapter 13).

7.2.9 Commercial Fishing by Other Countries

As described in Section 7.2.2, the DFO datasets record primarily domestic fish harvests and harvesting locations for species that are landed in Canada. However, the waters off Newfoundland and Labrador have also long been the focus of commercial fishing activity by the fleets of many foreign countries (Amec 2014), particularly in the areas beyond the 200-nautical-mile EEZ and within the NAFO Regulatory Area.

As noted in Section 7.2.1, NAFO manages most fisheries in the NRA (the part of the overall Convention Area outside any nation's EEZ), but it also has management responsibilities for several species within the Canadian EEZ. These are primarily "straddling stocks", which typically span domestic and international waters. DFO (2017d) reports, that:

> *NAFO management covers most fishery resources in the Northwest Atlantic except salmon, tunas/marlins, whales, and sedentary species (e.g. snow crab, lobster and various clams). NAFO covers the following straddling stocks: cod in NAFO division(s) 3NO, redfish in 3LN and 3O, American plaice in 3LNO, yellowtail flounder in 3LNO, witch flounder in 3L and 3NO, white hake in 3NO, capelin in 3NO, skates in 3NO, Greenland halibut in 3LMNO, squid in sub-areas 3 & 4, and shrimp in 3L.*

The following provides an overview of these NAFO fisheries and reports catch quantities at the NAFO Division level, as identified in Section 7.2.1. Note that these data include the same Canada-landed catches for relevant species included in the DFO data presented in Section 7.2.4 for the description of the domestic commercial fisheries.

Figure 7.60 shows quantities of harvests in the two key NAFO Divisions that overlap the Project Area, by year, for the ten-year period 2007 to 2016, which is the latest data currently available from NAFO (Statlant 21A 2017-09-13 update). The graph includes Canadian catches, and all foreign catches aggregated. Table 7.19 provides catch statistics by nation for 2007–2016 (averages) and for 2016. Table 7.20 shows the composition of the recorded catches, by species for foreign nations only, for the same time periods.

Figure 7.60 Canadian and Foreign NAFO Divisions 3L and 3M Quantity of Harvest by Year, 2007 - 2016

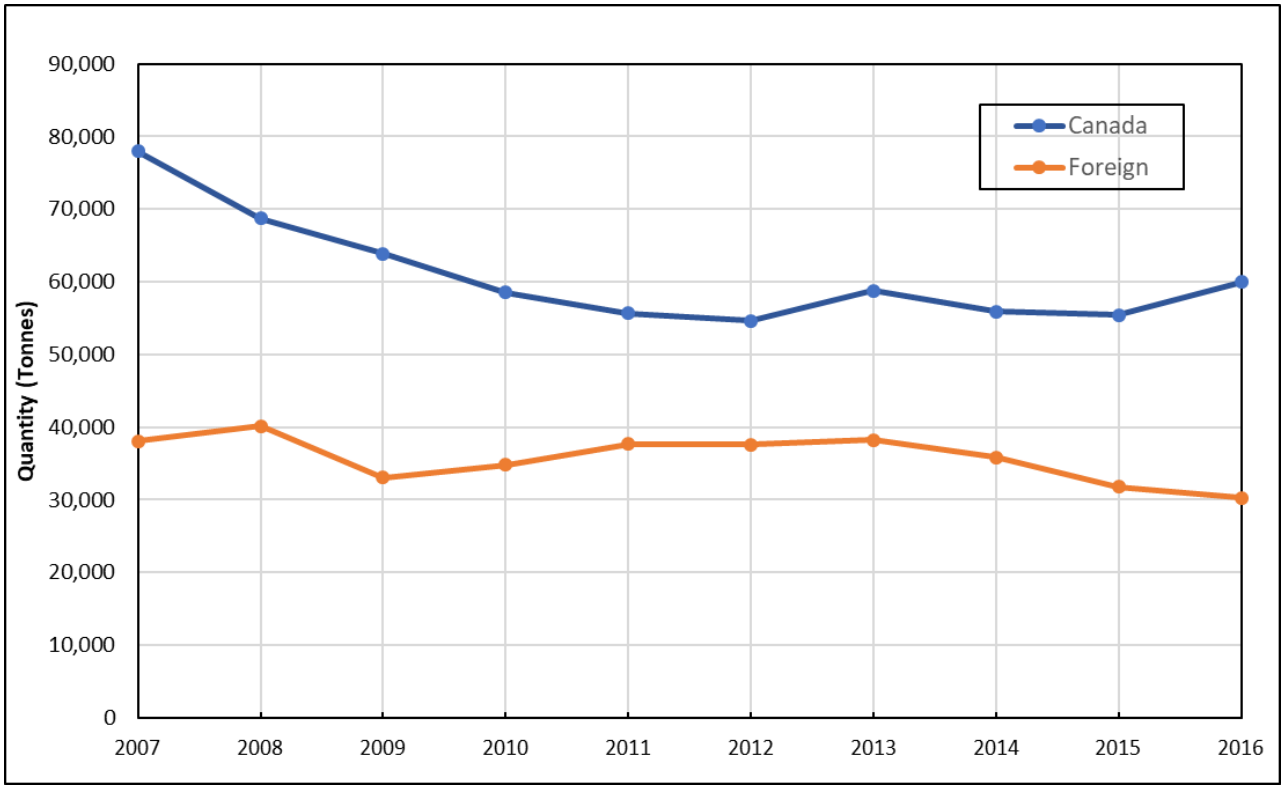


Table 7.19 Quantity of Harvest by Canadian Region and Foreign Nation, NAFO Divisions 3L and 3M 2007–2016 Average and 2016

Nation/Region	Average Quantity (t) 2007-2016	Quantity (t) 2016	% of 2007-2016 Quantities	% of 2016 Quantities
Canada – Newfoundland and Labrador	60,242	60,004	62.3%	66.5%
Canada - Maritimes	709	-	0.7%	0.0%
Canada - Scotia - Fundy	43	-	0.0%	0.0%
Portugal	9,536	12,388	9.9%	13.7%
Spain	9,179	6,555	9.5%	7.3%
Estonia	4,403	1,430	4.6%	1.6%
Russia	4,128	3,145	4.3%	3.5%
Faroe Islands	4,008	3,413	4.1%	3.8%
Norway	1,177	1,350	1.2%	1.5%
Latvia	694	-	0.7%	0.0%
Lithuania	565	-	0.6%	0.0%
United Kingdom	526	1,209	0.5%	1.3%
Japan	471	792	0.5%	0.9%
France St. Pierre et Miquelon	432	-	0.4%	0.0%
Cuba	282	-	0.3%	0.0%

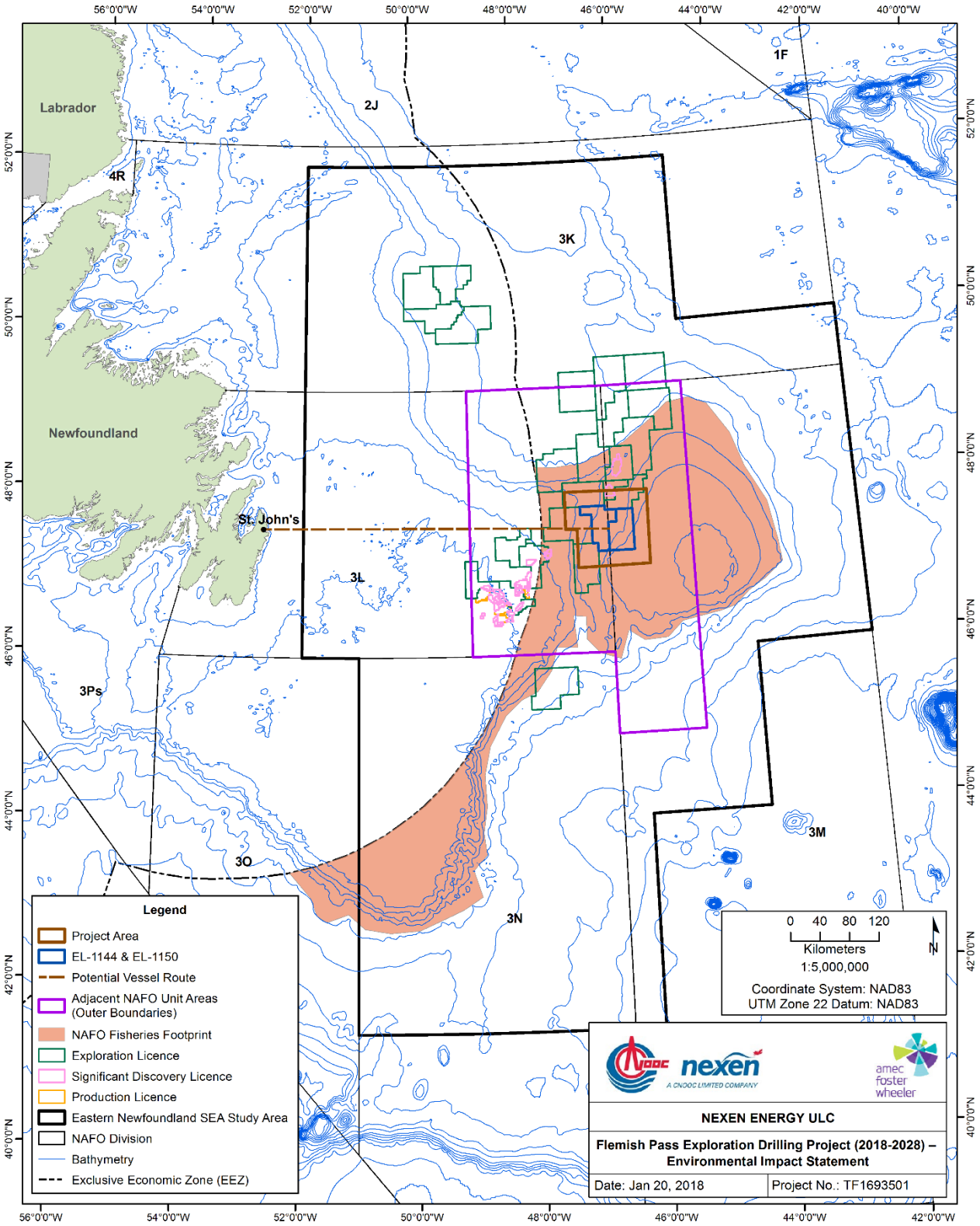
Nation/Region	Average Quantity (t) 2007-2016	Quantity (t) 2016	% of 2007-2016 Quantities	% of 2016 Quantities
Denmark Greenland	200	-	0.2%	0.0%
Poland	41	-	0.0%	0.0%
Iceland	40	-	0.0%	0.0%
United States of America	36	-	0.0%	0.0%
Federal Republic of Germany	30	-	0.0%	0.0%
Totals	96,741	90,286	100.0%	100.0%

Table 7.20 Foreign (Non-Canadian) Quantity of Harvest by Species, NAFO Divisions 3L and 3M 2007–2016 Average and 2016

Species	Average Quantity (t) 2007- 2016	Quantity (t) 2016	% of 2007- 2016 Quantities	% of 2016 Quantities
Redfishes	8,690	7,771	24.3%	25.7%
Turbot/Greenland Halibut	7,995	6,670	22.4%	22.0%
Atlantic Cod	7,884	11,602	22.1%	38.3%
Northern Shrimp	7,097	-	19.9%	0.0%
Sharks	1,479	-	4.1%	0.0%
Roughhead Grenadier	496	134	1.4%	0.4%
Roundnose Grenadier	316	172	0.9%	0.6%
American Plaice	307	954	0.9%	3.2%
Skates (ns)	253	206	0.7%	0.7%
Witch Flounder	245	344	0.7%	1.1%
Atlantic Halibut	194	1,292	0.5%	4.3%
Swordfish	170	-	0.5%	0.0%
Wolffishes (catfish)	113	54	0.3%	0.2%
Haddock	105	626	0.3%	2.1%
Dogfishes (ns)	87	213	0.2%	0.7%
Red Hake	73	4	0.2%	0.0%
Finfishes (ns)	72	-	0.2%	0.0%
Greenland Cod	42	-	0.1%	0.0%
White Hake	36	15	0.1%	0.0%
Tunas	20	-	0.1%	0.0%
All Other	76	225	0.2%	0.7%
Totals	35,749	30,282	100.0%	100.0%
ns=not specified				

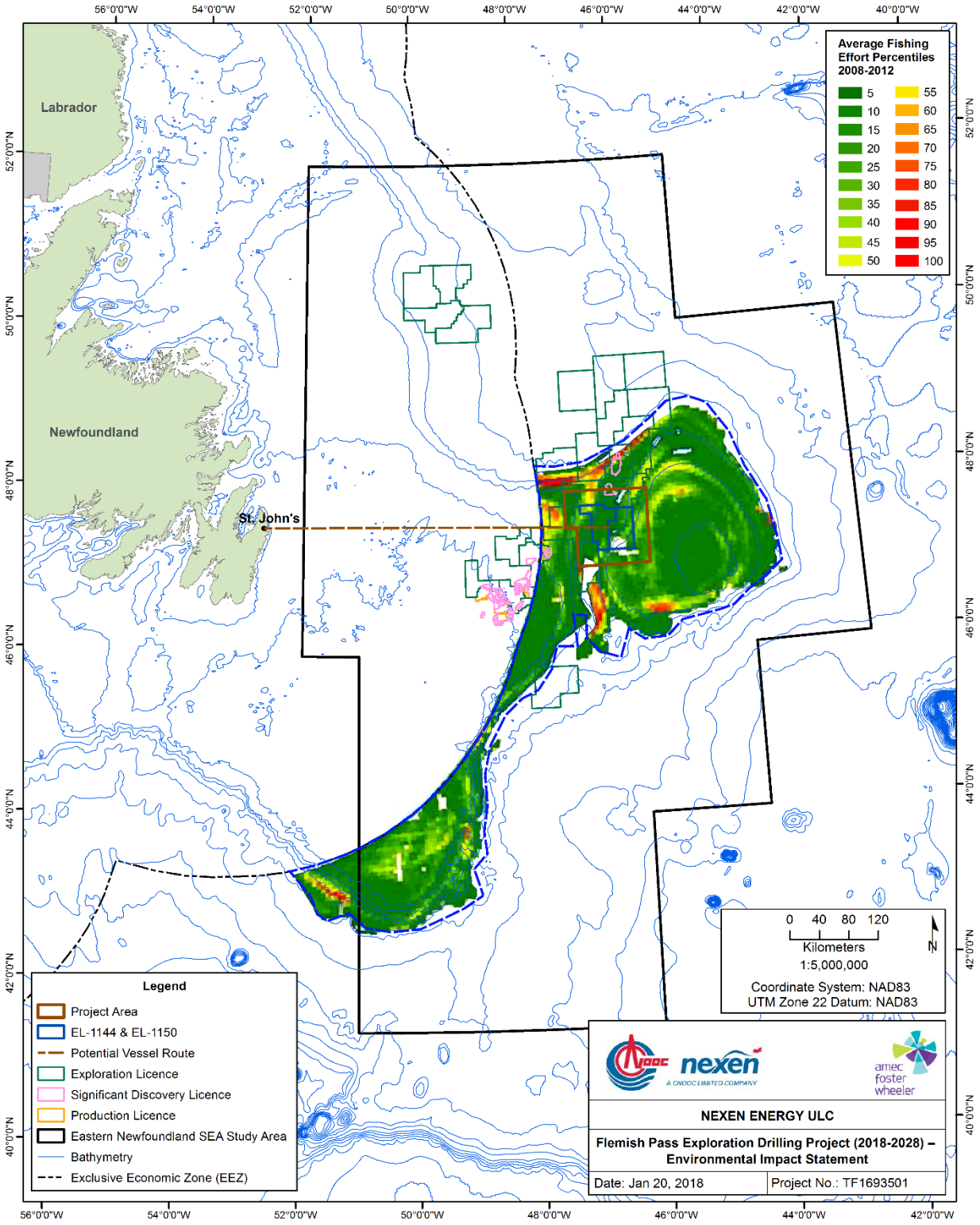
The maps that follow show views of overall fishing activity in the NRA. Figures 7.61 illustrates the area within which fishing usually occurs outside the EEZ (NAFO 2017b) – the NRA harvesting “footprint”. Figure 7.62 is based on ship-based Vessel Monitoring System (VMS) transponder records for the period 2008-2012, as provided by NAFO, which indicate relative levels of fishing intensity within the footprint area (WGEAFM 2012; NAFO 2014, cited in Amec 2014).

Figure 7.61 NAFO NRA Fisheries "Footprint"



Source: Amec (2014)

Figure 7.62 Average Fishing Effort in 5th Percentile Categories using Gridded VMS Data (2008-2012)



Source: Amec (2014)

With regard to the larger RSA, the following provides an overview of NAFO fisheries in Divisions 3KLMNO using the datasets and methods described above for the Division 3L and 3M fisheries. As noted, the NAFO dataset values presented below include some Canada-landed catches for relevant species which are also included in the DFO data presented previously.

Figure 7.63 shows quantities of harvests reported from these five NAFO Divisions by year for the ten-year period 2007 to 2016, based on the latest data currently available from NAFO (Statlant 21A, 9 September 2017 NAFO Update).The graph includes Canadian catches, and all foreign catches, aggregated. Table 7.21 provides catch statistics by nation for 2007–2016 (averages). Table 7.22 shows the composition of the recorded catches, by species for foreign nations only, for the same time periods, and Figure 7.64 indicates the relative harvest by Division by all foreign nations from within the 3KLMN area. Figures 7/61 and 7.62 above also show the relationship of the main NAFO harvesting locations (the NAFO “footprint”) to the adjacent 3KLMNO Divisions.

Figure 7.63 NAFO Divisions 3KLMNO Quantity of Canadian and Foreign Harvest by Year, 2007 – 2016

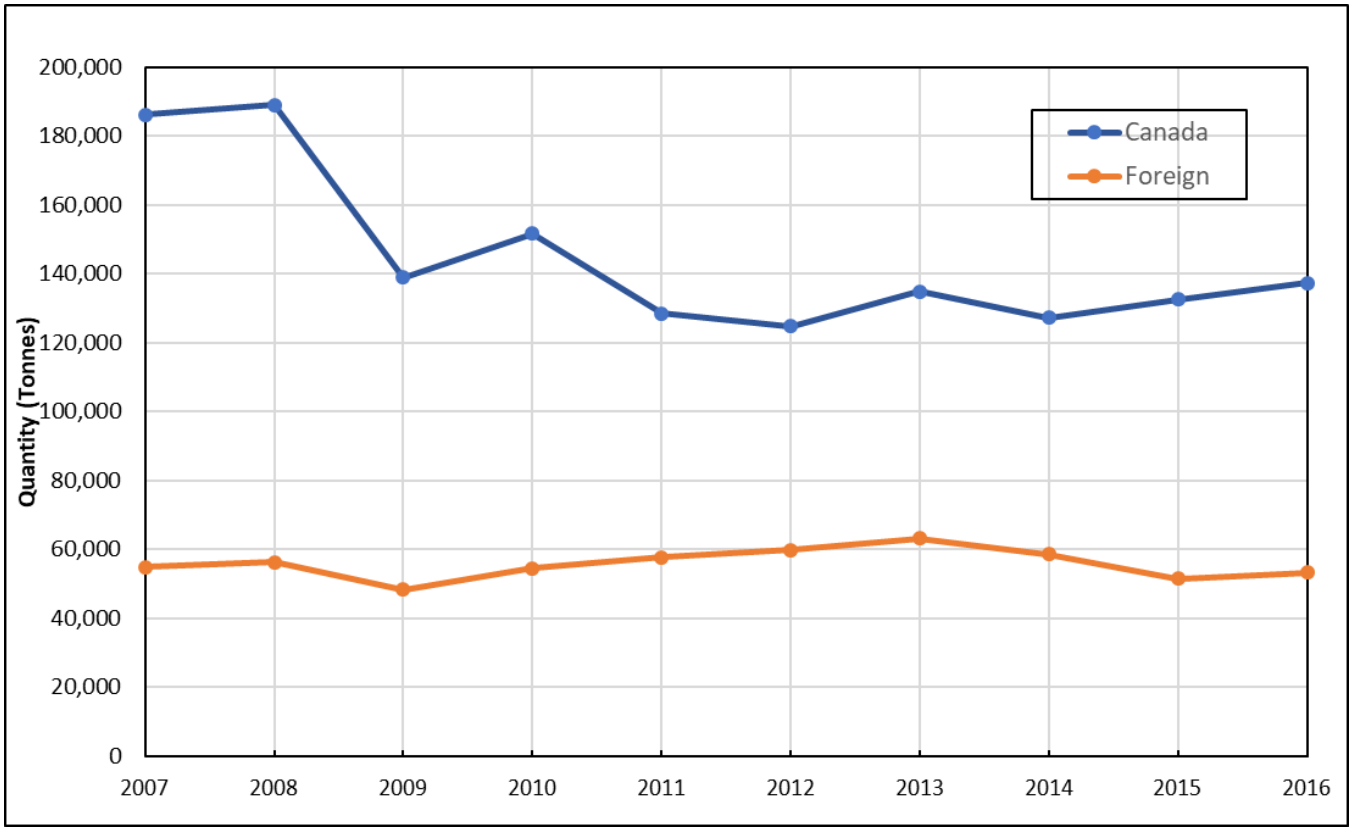


Table 7.21 NAFO Divisions 3KLMNO Quantity of Harvest by Canadian Region and Foreign Nation, 2007–2016 Average

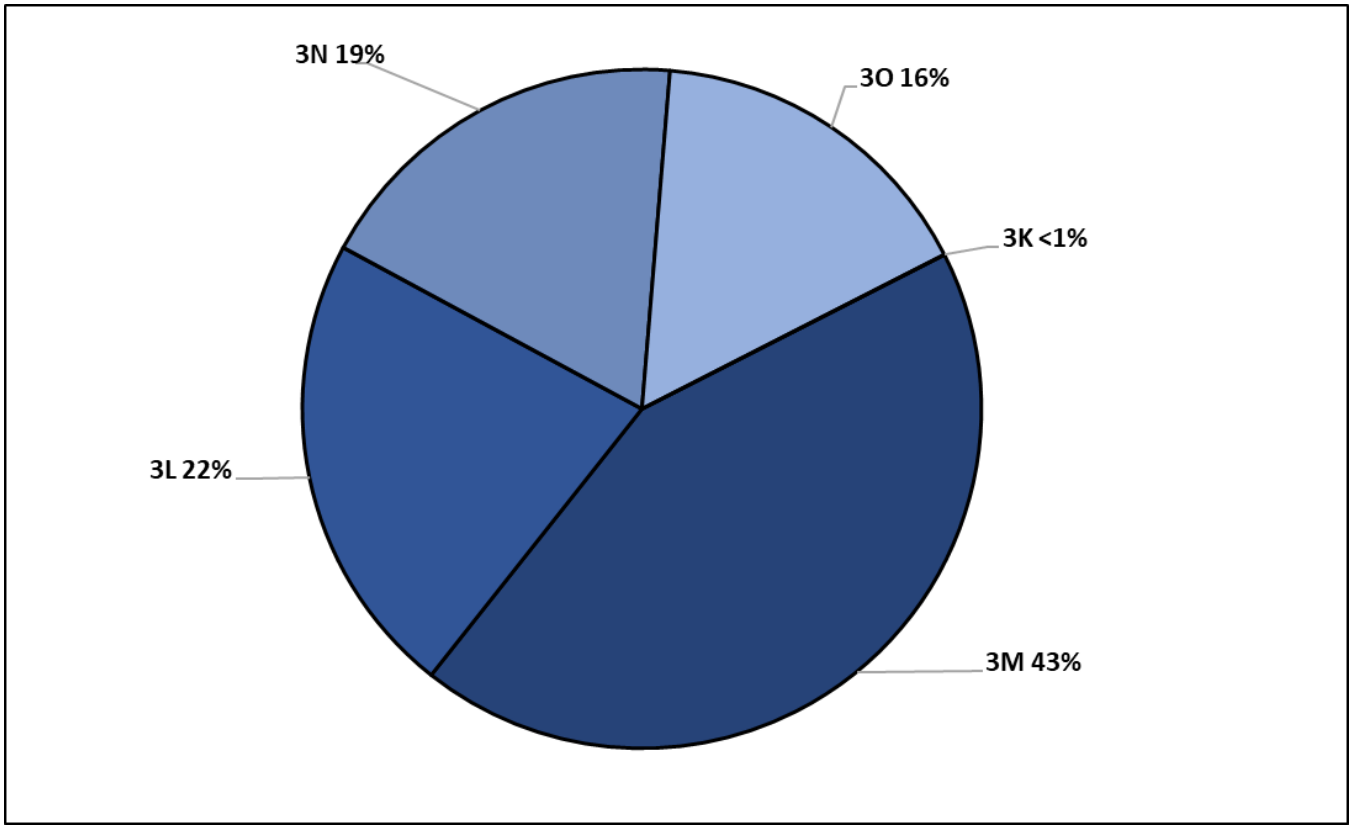
Nation/Region	Average Quantity (t) 2007-2016	% of 2007-2016 Total
Canada – Newfoundland and Labrador	143,312	71.3%
Canada - Maritimes	1,759	0.9%
Canada - Scotia - Fundy	1,156	0.6%
Canada - Quebec	16	0.0%
Spain	17,980	8.9%
Portugal	15,917	7.9%
Russia	6,123	3.0%
Estonia	5,134	2.6%
Faroe Islands	4,083	2.0%
Norway	1,177	0.6%
France St. Pierre et Miquelon	780	0.4%
Latvia	702	0.3%
Lithuania	660	0.3%
Japan	639	0.3%
United Kingdom	526	0.3%
United States of America	328	0.2%
Cuba	313	0.2%
Denmark Greenland	201	0.1%
Poland	41	0.0%
Iceland	40	0.0%
Federal Republic of Germany	30	0.0%
Denmark Mainland	1	0.0%
Total (Average Annual)	200,918	100.0%

Table 7.22 NAFO Divisions 3KLMNO Foreign Quantity of Harvest by Species, 2007–2016 Average

Species	Average Quantity (t) 2007-2016	% of 2007- 2016 Total
Redfishes	16,640	30.4%
Turbot/Greenland Halibut	9,067	16.6%
Atlantic Cod	8,481	15.5%
Northern Shrimp	7,107	13.0%
Skates (ns)	4,769	8.7%
Sharks	2,457	4.5%
Yellowtail Flounder	1,306	2.4%
American Plaice	1,096	2.0%
Roughhead Grenadier	613	1.1%

Species	Average Quantity (t) 2007-2016	% of 2007- 2016 Total
Witch Flounder	498	0.9%
Atlantic Halibut	460	0.8%
Roundnose Grenadier	394	0.7%
Silver Hake	368	0.7%
Haddock	256	0.5%
Swordfish	233	0.4%
White Hake	196	0.4%
Wolffishes (catfish)	166	0.3%
Dogfishes (ns)	131	0.2%
Finfishes (ns)	90	0.2%
Red Hake	84	0.2%
American Angler	80	0.1%
Groundfishes (ns)	46	0.1%
Greenland Cod	42	0.1%
Tunas	33	0.1%
All Other Species	64	0.1%
Totals (Average Annual)	54,675	100.0%
*ns=not specified		

Figure 7.64 NAFO Divisions 3KLMNO Relative Quantity of Foreign Harvest by Division, 2007 – 2016



7.2.10 Industry and DFO Research Surveys

Several fisheries science programs may occur within parts of the Adjacent UAs during the temporal scope of this EA. These surveys are conducted by both government (DFO) and/or industry groups, and are important to the fishing industry and to DFO managers because the survey results provide biomass indices that may be used to modify quotas and other aspects of a fishery's management regime.

7.2.10.1 DFO Multispecies Research Vessel (RV) Trawl Surveys

As in other regions of Canada's oceans, DFO conducts annual standardized bottom-trawl surveys to collect information for managing and monitoring fish resources in the Newfoundland and Labrador Region. Spring surveys have been conducted in NAFO Divisions 3LNOPs since 1975, while fall surveys began in NAFO Divisions 2HJ3KLMNO in 1977. The spring and fall surveys take place in different but overlapping areas. While the survey design has remained somewhat consistent, there may be some annual variation in exact location and timing (Figure 7.65). Since 1995, these surveys have been conducted by Canadian Coast Guard research vessels using a Campelen 1800 shrimp trawl. The tentative 2017 schedule for DFO RV surveys in the various NAFO Divisions is provided in Table 7.23.

Table 7.23 DFO Research Vessel Surveys within Project Area NAFO Divisions, by Vessel, 2017

Vessel	Activity	NAFO Division	Tentative Start Date	Tentative End Date
CCGS Needler	NL Spring Survey	3L+3N	May 24	June 10
	NL Fall Survey	3N+3L	October 11	October 24
		3L	October 24	November 7
		3K+3L	November 8	November 21
			November 21	December 2
CCGS Teleost	NL Spring AZMP[1]	3L	April 4	April 25
	Capelin Survey	3KL	May 2	May 23
	NL Summer AZMP[1]		July 8	July 29
	NL Fall Survey	3K+3L Deep	November 21	December 5
			December 6	December 20
[1] Atlantic Zone Monitoring Program Source: D. Power, pers comm 2017				

Table 7.24 shows the comparable 2017 research vessel dates and locations for these surveys in the larger RSA, in those Divisions (3K, 3N, and 3O) which do not overlap with the Project Area and are thus not included in Table 7.23 above.

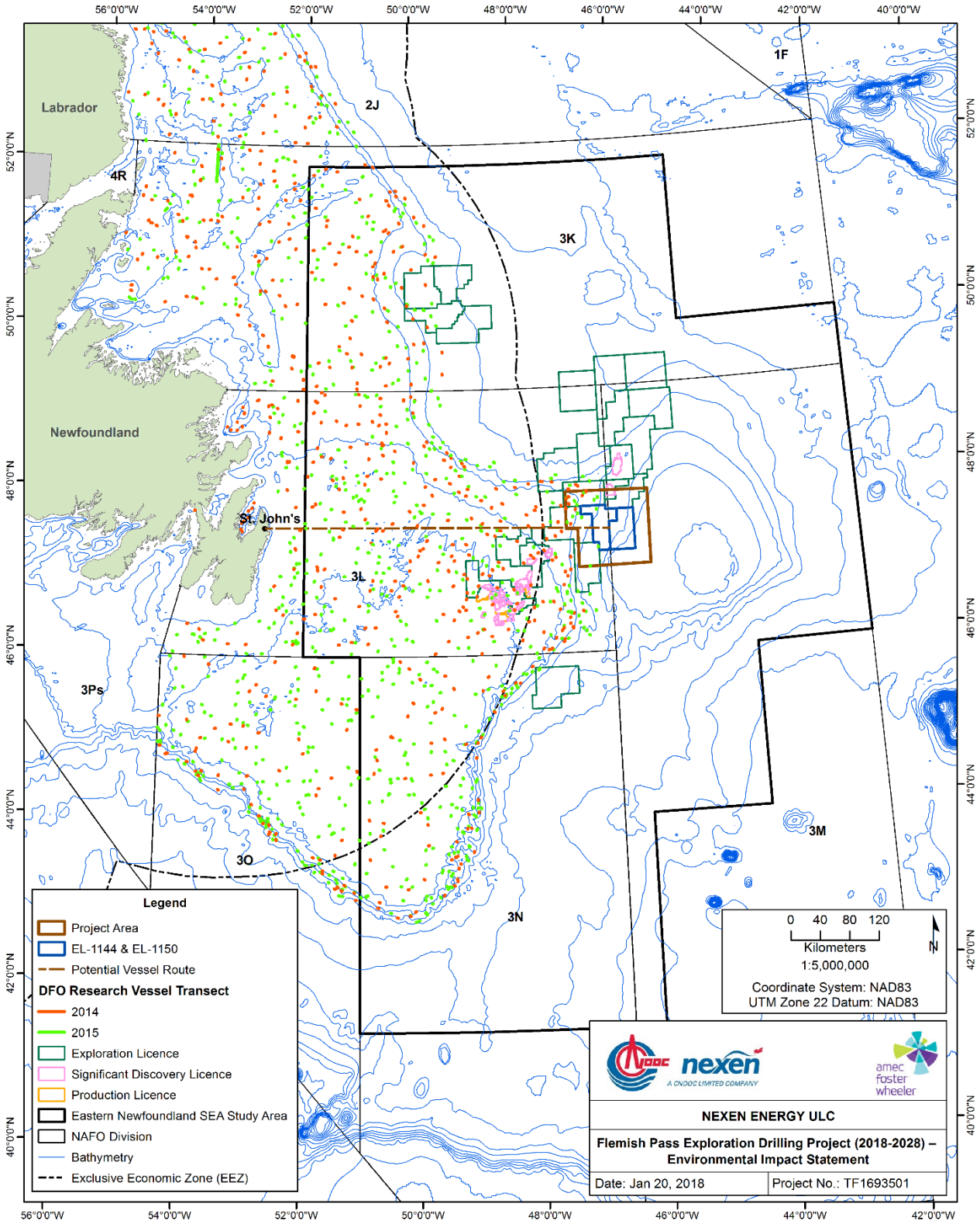
Table 7.24 DFO Research Vessel Surveys within NAFO Divisions 3KNO, by Vessel, 2017

Vessel	Activity	NAFO Division	Tentative Start Date	Tentative End Date
CCGS Needler	NL Spring Survey	3P+3O	26-Apr	9-May
		3O+3N	9-May	23-May
	NL Fall Survey	3O	13-Sep	26-Sep
		3O+3N	26-Sep	10-Oct
		2J+3K	24-Oct	7-Nov
CCGS Teleost	NL Fall Survey	3K	8-Nov	21-Nov
Source: D. Power, pers comm 2017				

7.2.10.2 Industry - DFO Collaborative Post-Season Snow Crab Trap Survey

Since 2003, an annual Industry - DFO Collaborative Post-season Trap Survey for snow crab has been conducted in many inshore and offshore areas within Newfoundland and Labrador Region waters as a research partnership between the FFAW-Unifor and DFO. It is conducted using commercial and modified snow crab traps at established trap stations starting in late August or early September after the commercial snow crab season has ended. The survey continues until all the stations selected for the year are finished, sometimes into late November. The station locations are determined by DFO, selected from a set of pre-established locations and up to 1,500 are surveyed annually. Each survey station is fixed and follows a general grid pattern (Stansbury et al, 2013, 2014; FFAW-Unifor 2017). Figure 7.66 shows the locations of the longstanding stations, which have been the principal focus of this survey, in relation to the Project Area. For 2018 and beyond, it is expected that 50 percent of the stations surveyed will be selected from these locations. The remaining station coordinates will be part of a stratified random design (R. Lee, pers comm 2018).

Figure 7.65 Location of DFO Research Vessel Survey Transects



7.2.10.3 CAPP Northern Shrimp Survey

To enhance research efforts, the Canadian Association of Prawn Producers (CAPP), a national Canadian organization representing the interests of at-sea producers of coldwater shrimp which conducts research and marketing activities on their behalf, and Northern Coalition have established the Northern Shrimp Research Fund (NSRF), a non-profit initiative that provides funding and a vessel for shrimp surveys from Northern Shrimp Fishing Areas. However, for 2017 and the foreseeable future no related surveys are planned in areas south of SFA 4 (northern Labrador Shelf) (B. Chapman, pers comm 2017).

7.2.10.4 Groundfish Enterprise Allocation Council Survey

Groundfish Enterprise Allocation Council (GEAC) and DFO-GEAC surveys occurred annually from 1997-2001 and biannually after 2001, using bottom trawls and a commercial trawler. However, no surveys are presently planned for 2017 or beyond in or near the Project Area (K. Vascotto, pers comm 2017).

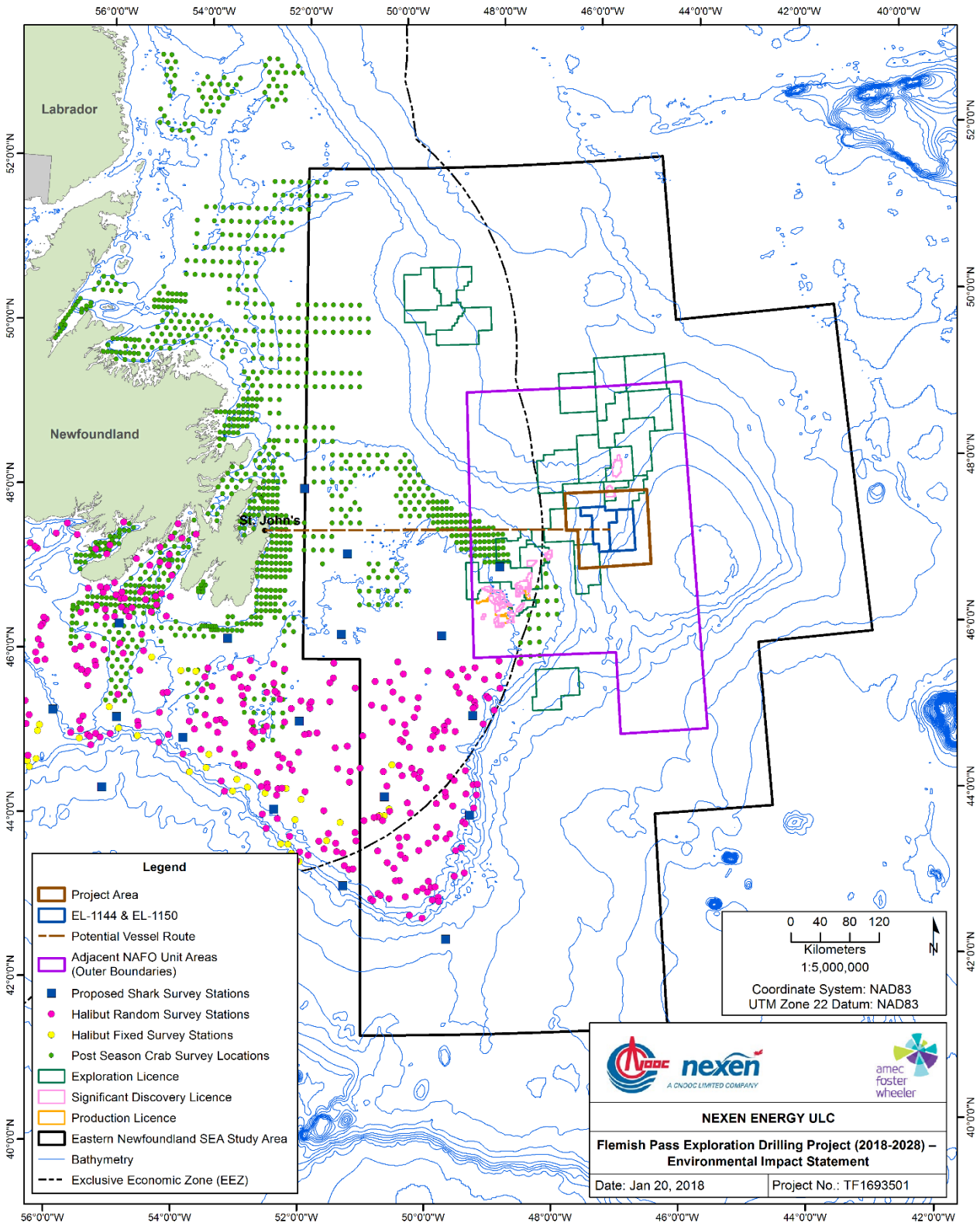
7.2.10.5 Industry – DFO Shark Survey

DFO (Bedford Institute, Halifax), in cooperation with Nova Scotia swordfish harvesters, planned a survey of sharks in set locations from Georges Bank to the eastern Grand Banks in 2017, and potentially in future years during the temporal scope of this EA. The survey consists of large-pelagic longline fishing for approximately eight hours (two hours to deploy, four to soak, two to haul) within 10 NMi of each of the locations shown in Figure 7.66 The timeframe for the survey is from June 14 until June 30. Active communications should be maintained with DFO in any potential survey year (H. Bowlby pers comm 2017). As illustrated in Figure 7.66, none of the planned survey locations are within or near the Project Area.

7.2.10.6 Industry-DFO Atlantic Halibut Survey

The annual Atlantic halibut abundance survey is a collaborative effort involving the FFAW-Unifor, the Eastern Shore Fisherman's Protective Association, the Shelburne County Quota Group and the Atlantic Halibut Council working with DFO. It occurs each summer from the end of May to the end of July, across the Scotian Shelf and southern Grand Banks Atlantic halibut management unit (3NOPs4VWX+5Zc). For 2017 and following years, the survey will expand its coverage in 3NOPs. The survey consists of fixed stations which are fished every year and additional random stratified stations that are chosen annually. Figure 7.66 shows the locations of both the fixed stations and the 2017 randomly chosen stations. The survey methodology varies slightly for the fixed vs. random sets, but both use halibut longlines approximately 5-km long on the sea floor, with about 1,000 hooks per line. Soak time is six to twelve hours, and the gear must be set between 0400 and 1200 local time (C. den Heyer, pers comm 2017). As illustrated in Figure 7.66, none of the planned survey locations are within or near the Project Area.

Figure 7.66 Locations of Industry - DFO Survey Stations



7.2.11 Sealing

DFO issues some 16,000 seal harvester licences annually in Atlantic Canada, and quotas are allocated to provincially-based fleets. Approximately 12,500 licensed harvesters (78 percent) reside in Newfoundland and Labrador (DFO 2011). The provincial seal hunt is mainly for harp seals, for which the season is November 15 to June 14 annually. The harvest occurs at “The Front” in Sealing Areas 5, 6, 7, 8, and 9 which are adjacent to the Newfoundland and Labrador coastline (Figure 7.67). Approximately 70 percent of the Canadian harvest occurs at The Front, beginning around the second week of April and ending when individual quotas are achieved or ice conditions are unfavourable (DFO 2011). According to the DFO 2016 management decision for harp seals the Total Allowable Catch for the species for the 2016 season was set at 400,000 animals, which was a rollover from the 2015 TAC (DFO 2017e).

7.2.12 Aquaculture

There are currently more than 150 licences for aquaculture operations along the coastlines of Newfoundland (Figure 7.68), the closest being more than 400 km away. In 2015, these coastal sites include 87 salmonid site licences, 51 shellfish operations, four hatcheries and 10 other ventures. The total value of production of the province’s aquaculture industry in that year was worth $161 million, an increase of nearly 200 percent from the previous year (DFA 2014, 2015; DFLR 2017).

7.3 Other Marine Components and Activities

The following sections describe and illustrate a number of other human activities and components that occur or exist within the offshore area of Eastern Newfoundland.

7.3.1 Marine Shipping and Transportation

Marine shipping and transportation play an important role in coastal areas throughout Newfoundland and Labrador. Traditionally, small to medium sized vessels transported goods and people to and from coastal communities. Currently, the road system is the primary mode of transportation, and marine shipping is limited mainly to sea ports with the required infrastructure and services for larger vessels (Figure 7.69).

In Canada, shipping ports are regulated through the *Public Ports and Public Port Facilities Regulations* (SOR/2001-154) of the *Canada Marine Act*. In 2011, international cargo to and from 17 shipping ports in Eastern Newfoundland represented approximately 12 percent of the total marine shipping conducted to and from all Newfoundland and Labrador ports (Table 7.25). Come By Chance and Fortune were key international ports (Figure 7.69). Fortune is the Newfoundland port of entry/exit for the nearby French islands of St. Pierre and Miquelon, and Come By Chance has a large number of shipping movements associated with the transfer of petroleum products at North Atlantic Refining (Statistics Canada 2012). A portion of tanker traffic from Newfoundland Transshipment Limited’s port at Whiffen Head is bound for international ports and may or may not be captured in these data. International vessels transecting the waters of Eastern Newfoundland may cross the Project Area and those using the Port of St. John’s may intersect with the marine area that will be crossed by Project-related supply vessel traffic.

Figure 7.67 Seal Harvesting Area

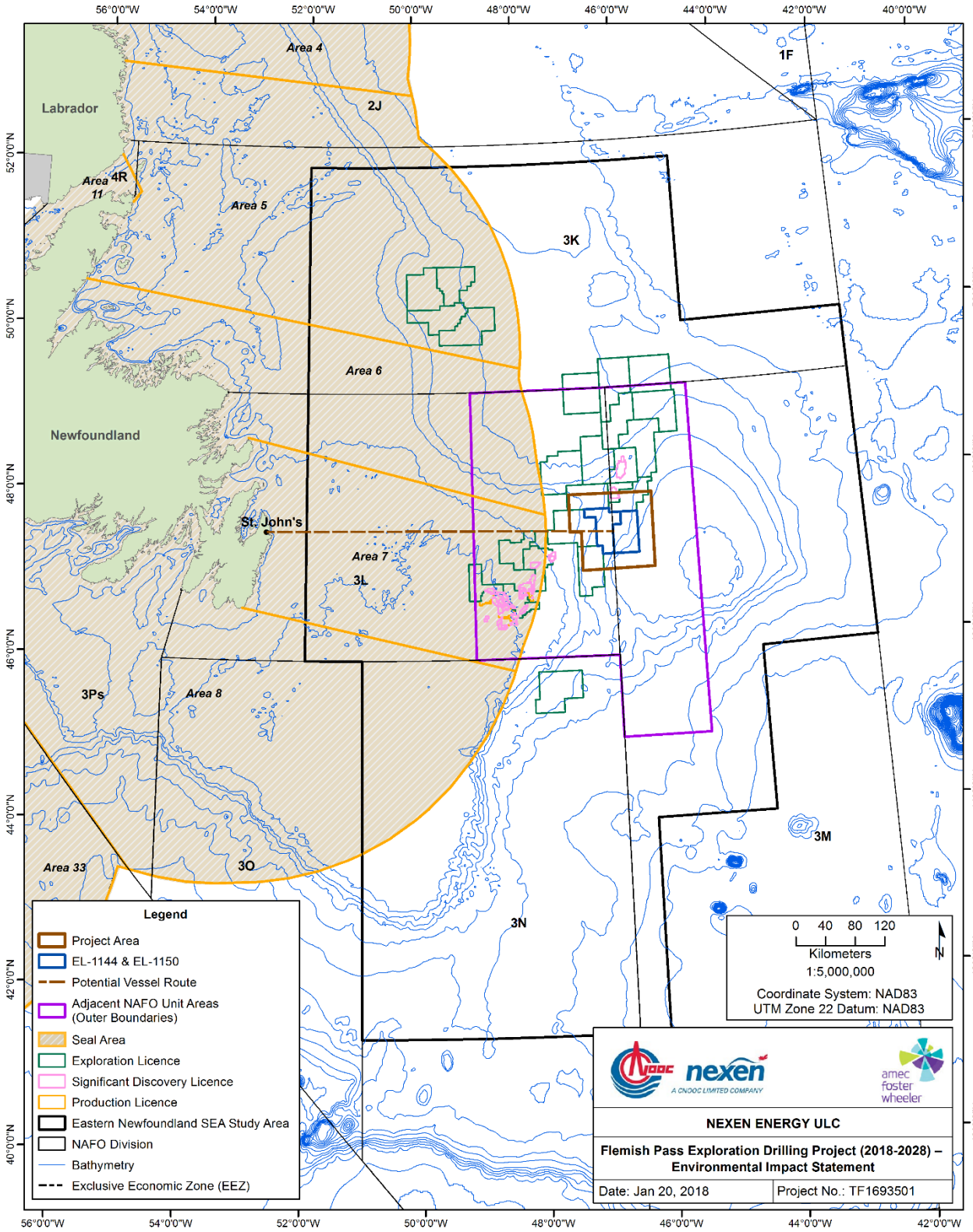


Figure 7.68 Aquaculture Sites on the Island of Newfoundland

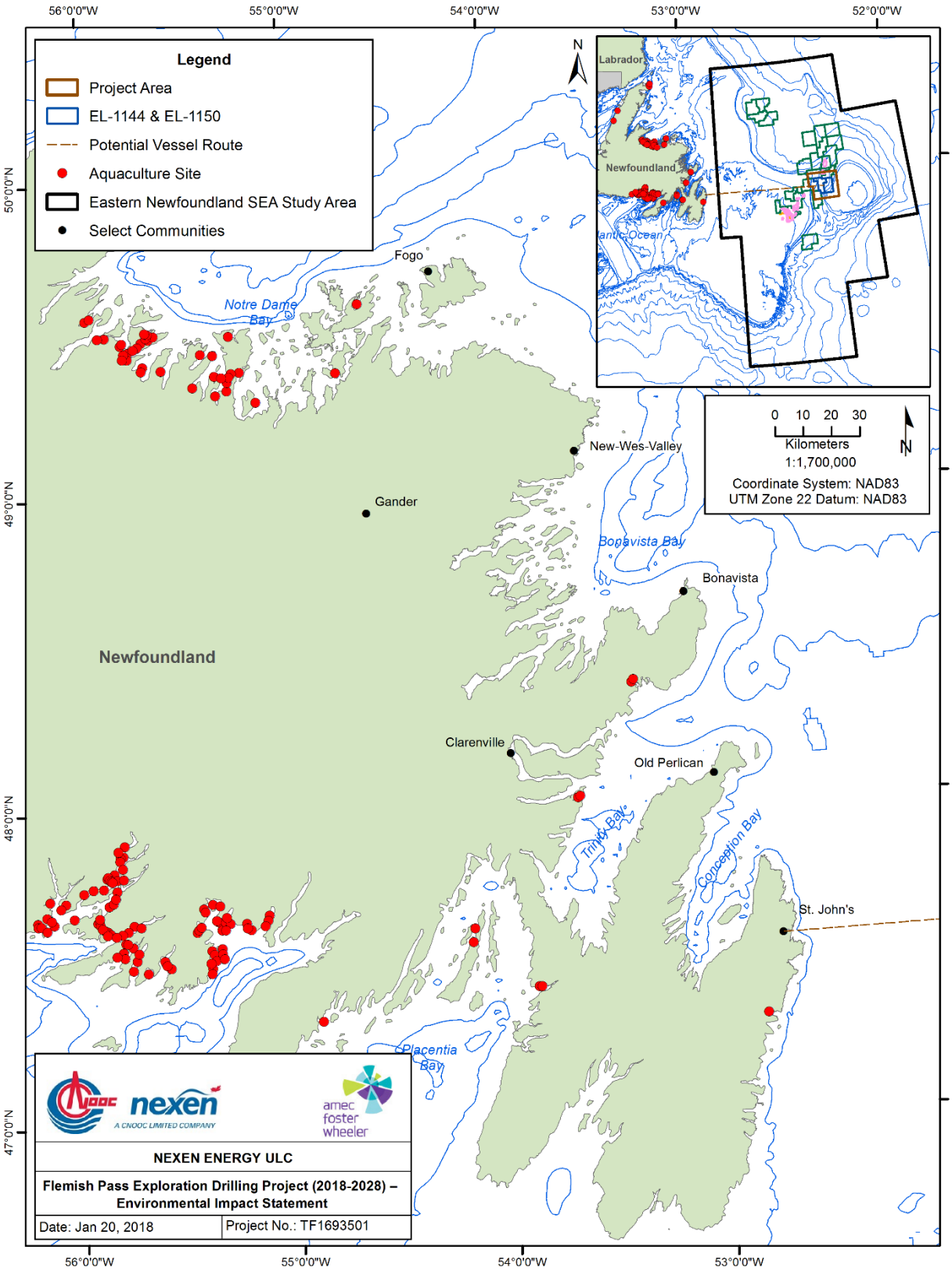


Table 7.25 International Shipping in Eastern Newfoundland (2011)

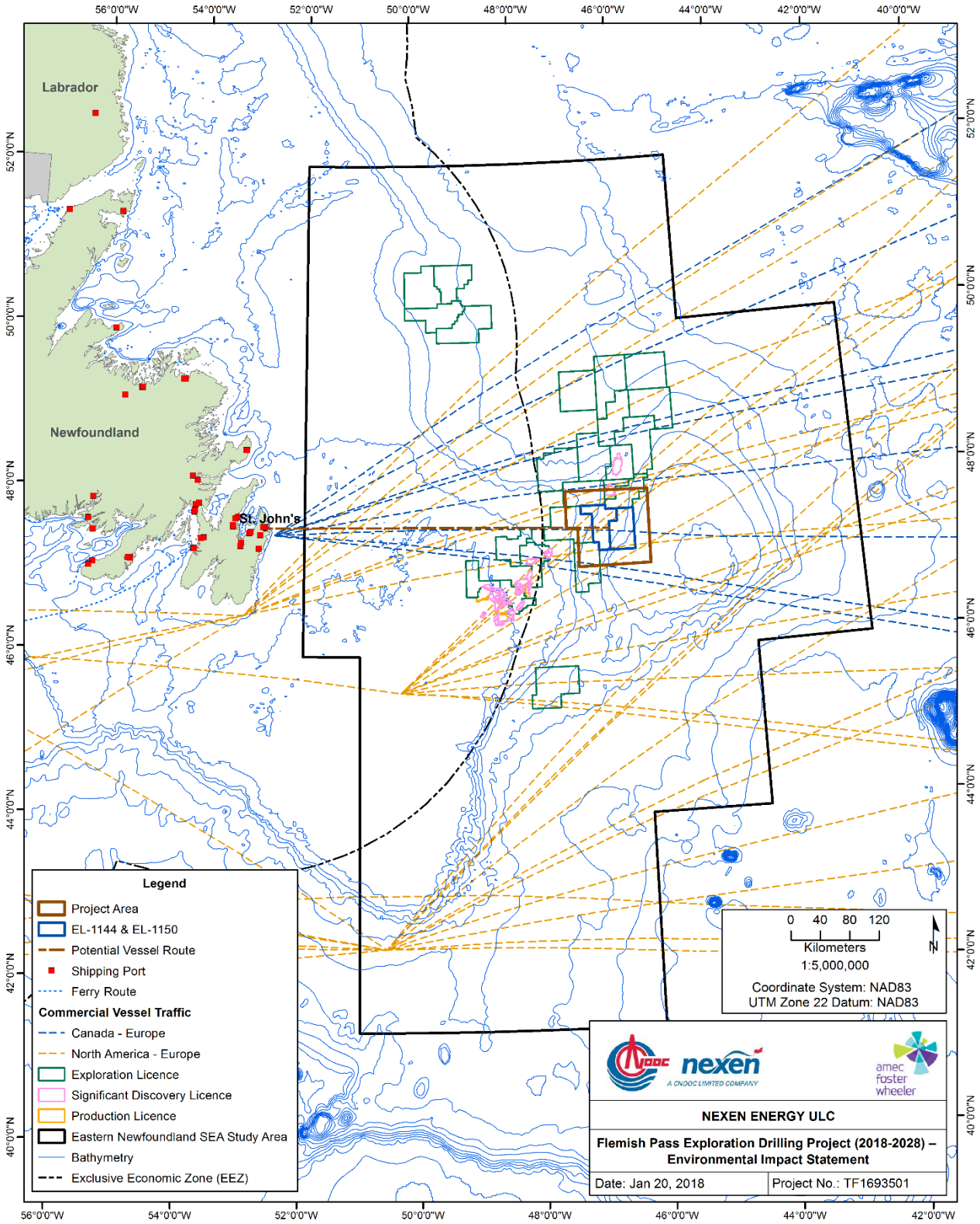
Selected Ports	Vessel Movements	Total Tonnage ('000 t)
Fortune	1,072	7
Come By Chance	433	14,911
Argentia	111	45
St. John's	49	8
Harbour Grace	22	9
Long Harbour	20	2
Newfoundland Offshore (St. John's)	19	1,272
Bay Bulls	17	19
Holyrood	16	246
Lewisporte	15	115
Bay Roberts	7	4
Long Pond	4	16
Marystown	2	0
Total	1,787	16,654
Note: These data have not been updated since 2011. Source: Statistics Canada (2012)		

Eastern Newfoundland and Labrador ports experience a larger number of annual domestic shipping movements than international activity (Table 7.26). The Port of St. John's, the busiest domestic shipping port in Eastern Newfoundland, includes shipping activity related to Eastern Newfoundland's offshore oil and gas industry (SC 2012). Come by Chance, Placentia Bay experiences vessel traffic associated with an oil refinery and other marine activities. Domestic tanker traffic from Newfoundland and Labrador Transshipment at Whiffen Head may or may not be included in these data. Domestic vessels are not likely to transit within or cross the Project Area itself.

Table 7.26 Domestic Shipping in Eastern Newfoundland (2011)

Selected Ports	Vessel Movements	Total Tonnage ('000 t)
St. John's	1,589	1,357.7
Newfoundland Offshore (St. John's)	1,406	12,391.4
Come By Chance	274	12,476.5
Lewisporte	99	150.4
Long Pond	89	229.9
Argentia	44	35.9
Clarenville	28	513.8
Holyrood	12	18.0
Catalina	11	3.4
Bay Roberts	9	49.3
Carmanville	6	15.1
Marystown	6	6.8
Arnold's Cove	1	0.0
Total	3,565	27,248.2
Source: Statistics Canada (2012)		

Figure 7.69 Marine Shipping and Transportation in Eastern Newfoundland



7.3.1.1 Port of St. John's

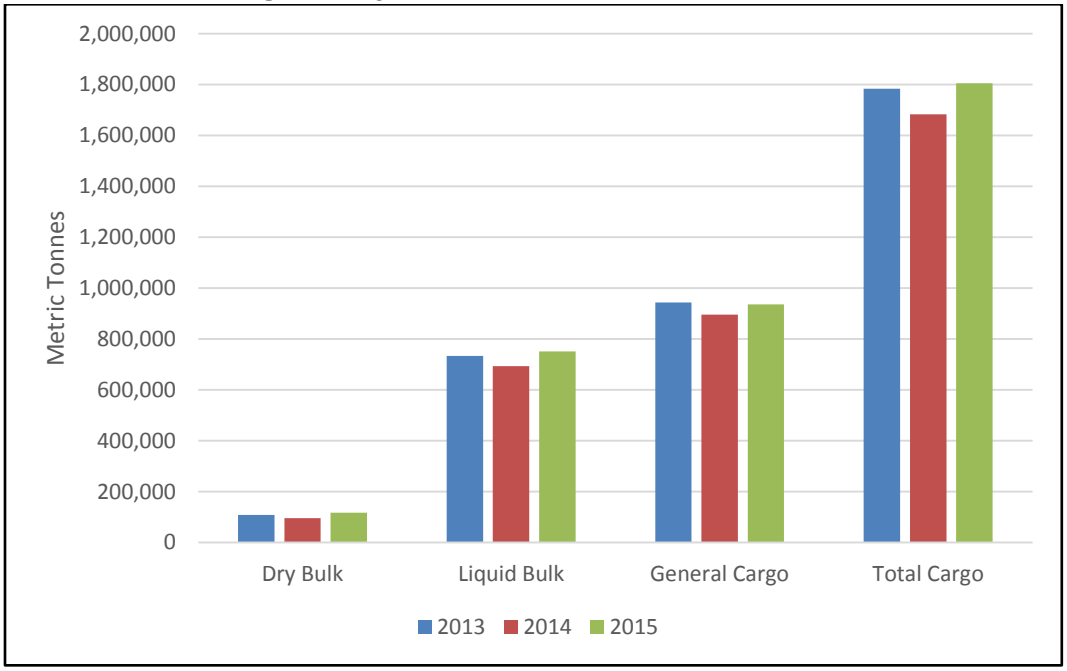
St. John's Harbour, operated by the St. John's Port Authority, is one of a series of Canada Port Authorities regulated under the *Canada Marine Act*. Canada Port Authorities include those deemed to be important for domestic and international shipping (TC 2016). St. John's is an important seaport in Atlantic Canada and a centre of activity for a number of industries in Eastern Newfoundland. It is the primary supply centre for the province's offshore oil and gas industry, a container terminal, fishing port and cruise ship port-of-call. Other activities at the Port of St. John's include Canadian Coast Guard (CCG) operations, fuel wholesale, military activity, ship repair and refitting, industrial fabrication and seafood unloading (SJPA 2016). St. John's had between 1,350 and 1,600 port arrivals annually from 2013 and 2015 (Table 7.27).

Table 7.27 Port Activity at St. John's Harbour

Port Activity	2013	2014	2015
Vessel Arrivals	1,601	1,545	1,358
Dry Bulk Cargo	108,008 MT	95,609 MT	116,577 MT
Liquid Bulk Carge	733,000 MT	692,418 MT	751,414 MT
General Cargo	942,954 MT	895,074 MT	936,126 MT
Total Cargo	1,783,962 MT	1,683,101 MT	1,804,117 MT
Source: SJPA (2016)			

Most cargo shipping activity at St. John's is related to general cargo movements (Figure 7.70). This includes goods moved in and out of Oceanex's container ship facility, which operates weekly sailings from Halifax and Montreal. Oceanex transports about half of the goods entering the Island of Newfoundland annually (SJPA 2016). Container ships travelling to and from St. John's and Halifax or Montreal are not likely to cross the Project Area.

Figure 7.70 Marine Shipping Activity at St. John's Harbour



Source: SJPA (2016)

7.3.1.2 Ferry Services

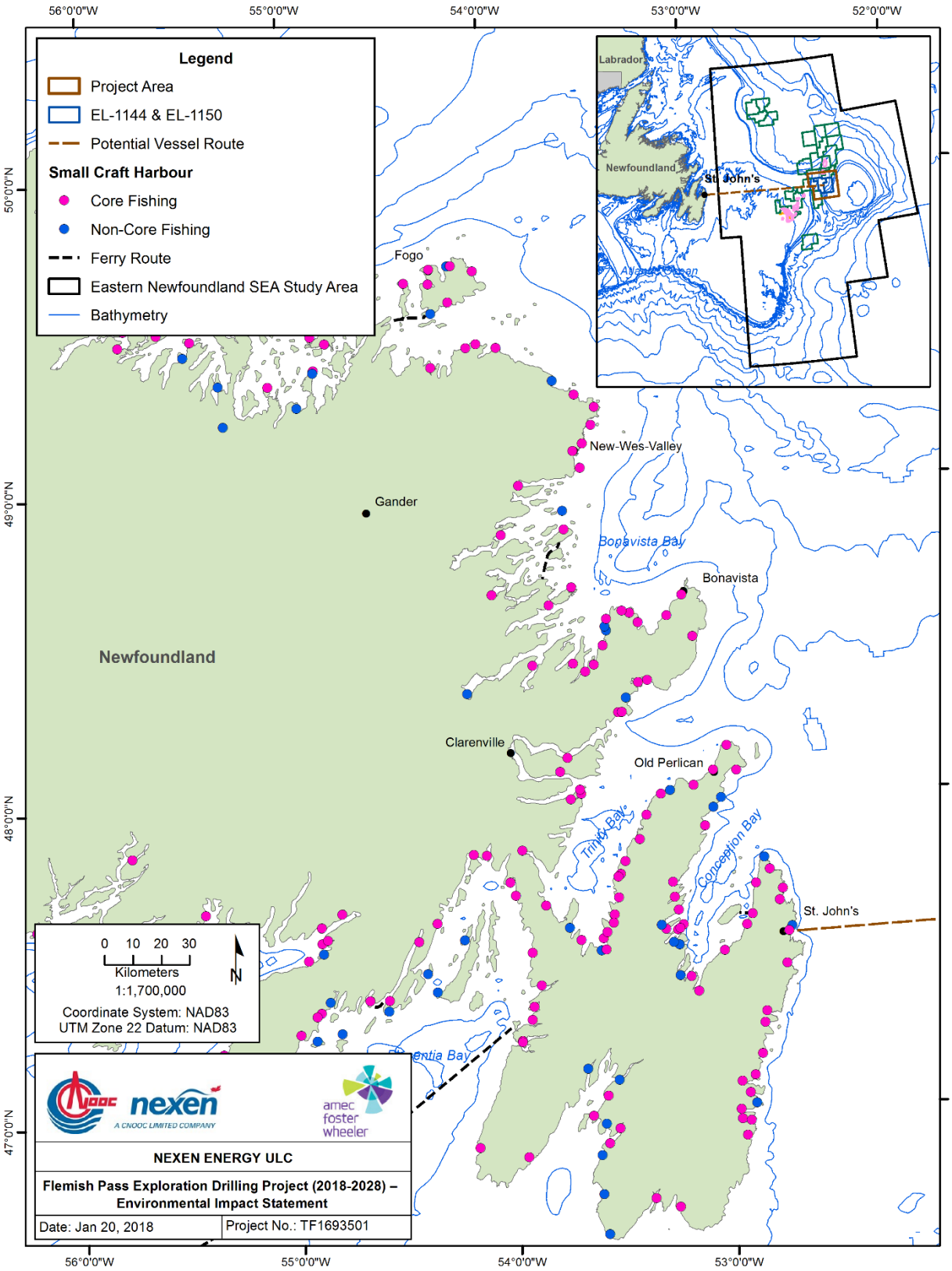
The Newfoundland and Labrador Department of Transportation and Works administers and operates a system of ferries in the province. These services deliver passengers and freight to remote coastal communities that are not connected by road. Four provincial ferry services operate in Eastern Newfoundland: 1) Farewell - Change Islands/Fogo Island; 2) Burnside - St. Brendan's; 3) Portugal Cove - Bell Island; and 4) Southeast Bight - Petit Forte. There are also regular ferry services between Fortune, Newfoundland and the French islands of St-Pierre and Miquelon (NLTW 2017). None of these ferry routes are near Project Area (Figure 7.71).

An interprovincial ferry service provides access to North Sydney, Nova Scotia from Port aux Basques and Argentia, NL. The Argentia ferry, which is located in Eastern Newfoundland, operates one to three times per week from June to September annually (MAI 2017). Commercial traffic includes tractor trailers moving goods between Newfoundland and Nova Scotia.

7.3.1.3 Small Craft Harbours

Small craft harbours are regulated through the *Canadian Fishing and Recreational Harbours Act* and *Fishing and Recreational Harbours Regulations*. Newfoundland and Labrador has a total of 339 small craft harbours, a large number of which are located in Eastern Newfoundland (Figure 7.71). The 261 core fishing harbours, which are considered to be critical to the fishing and aquaculture industries, are owned by DFO and for the most part managed by the 207 Harbour Authorities in the province (DFO 2017f). Non-core harbours may also have some level of fishing activity and small craft harbours are often used for recreational boating and marine tourism.

Figure 7.71 Small Craft Harbours in Eastern Newfoundland



7.3.1.4 Marine Traffic Management

In Canada, vessel traffic is managed by CCG under the *Canada Shipping Act, 2001*. DFO, through CCG Marine Communications and Traffic Services (MCTS), provides communications and traffic management services in certain Canadian ports. In Eastern Newfoundland, MCTS Centres are located in St. John's and Placentia with various peripheral radio sites in other locations (Figure 7.72). The MCTS are responsible for detecting marine distress situations and ensuring that information and assistance are available to mariners. They broadcast safety information, direct and provide advice to marine traffic, ensure ports and traffic movements are efficient and optimized and assist in the operations of harbour pilots (CCG 2016a).

Compulsory pilotage areas are established under the *Pilotage Act* and *Atlantic Pilotage Authority Regulations* and managed through the Atlantic Pilotage Authority service system. In Eastern Newfoundland, compulsory pilotage areas are located at St. John's, Holyrood and Placentia Bay. The compulsory pilotage boarding area for St. John's Harbour is an area including two nautical miles east of the entrance. The compulsory pilotage area for Placentia Bay includes the northern portion of the Eastern Channel (APA 2013).

The following types of ships are required to have a pilot on board to sail within compulsory areas:

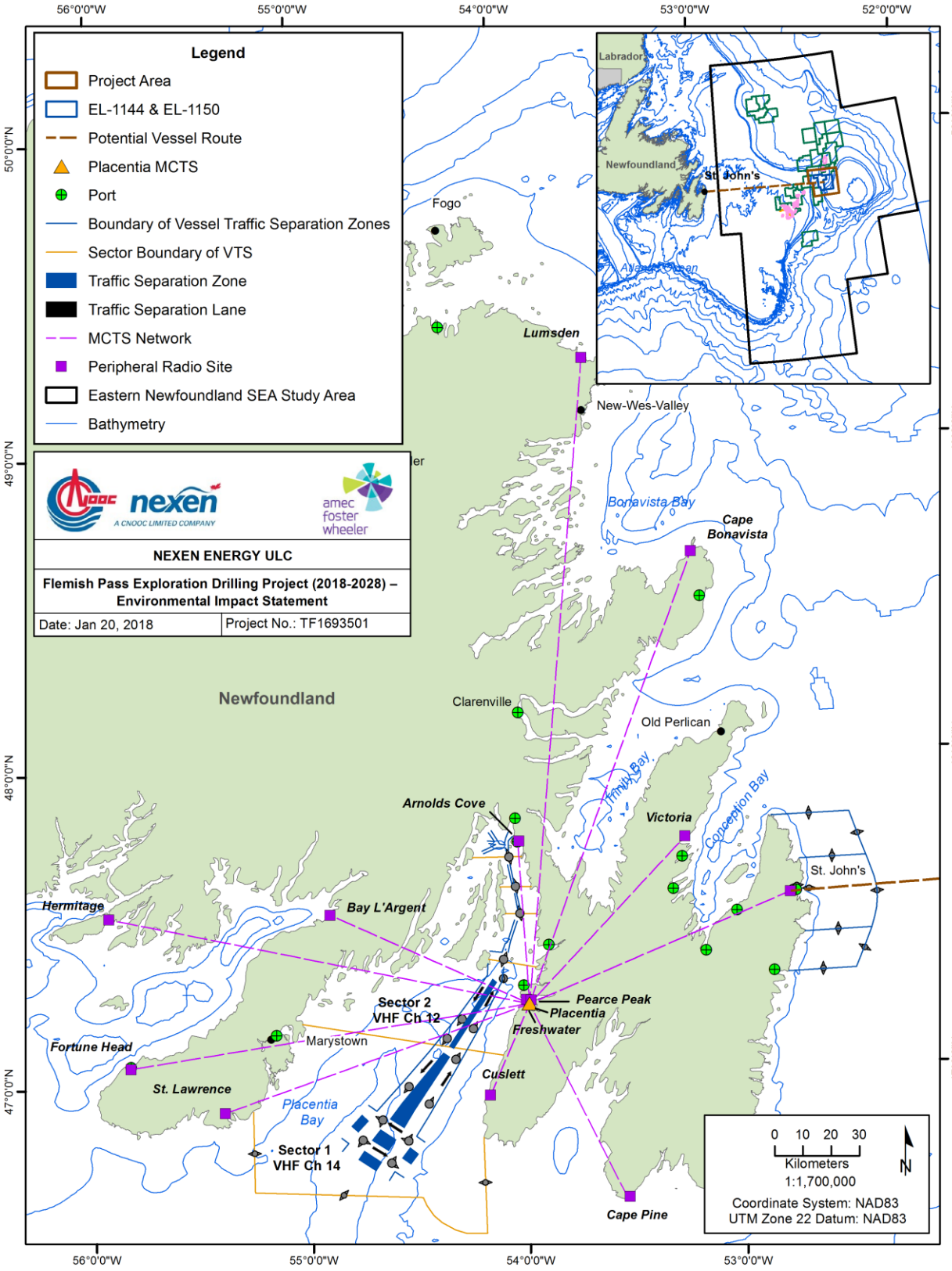
- Canadian registered ships of more than 1,500 gross tons;
- Ships not registered in Canada;
- Oil rigs;
- Pleasure craft over 500 gross tons;
- Any combination of tug and tow, if more than one unit is being towed; and
- Ferries entering or leaving a port that is not one of their regularly scheduled terminals.

Section 4 of the *Atlantic Pilotage Authority Regulations* provides a complete list of vessels exempted from compulsory pilotage, which includes:

- Canadian-government ships;
- Canadian-registered vessels catching/processing seafood or other living marine resources; and
- Canadian-registered offshore supply vessels of 5,000 gross tons or less that have an operations base in a port located within compulsory piloting areas (APA 2013).

In Eastern Newfoundland, vessel traffic service areas are enforced around St. John's Harbour and in Placentia Bay (Figure 7.72). Vessels are required to contact MCTS Centres from designated points to receive instructions. A vessel traffic separation scheme is also enforced in Placentia Bay (CCG 2016b).

Figure 7.72 Marine Traffic Management in Eastern Newfoundland



7.3.2 Petroleum Exploration and Production Activity

The Eastern Newfoundland Offshore Area is subject to considerable oil and gas exploration activity, including geophysical, geotechnical and geological surveys and drilling programs, with many thousands of kilometers of seismic survey data collected and several hundred wells having been drilled to date (Figure 7.73, see also Section 15.1.3). Offshore petroleum production activities have also been occurring since the 1990s, and currently includes several producing oilfields (Hibernia, Terra Nova, White Rose, Hebron) (Table 7.28). These offshore oil and gas exploration and development activities include a variety of ancillary and supporting activities as well (NOIA 2016; NLF 2017).

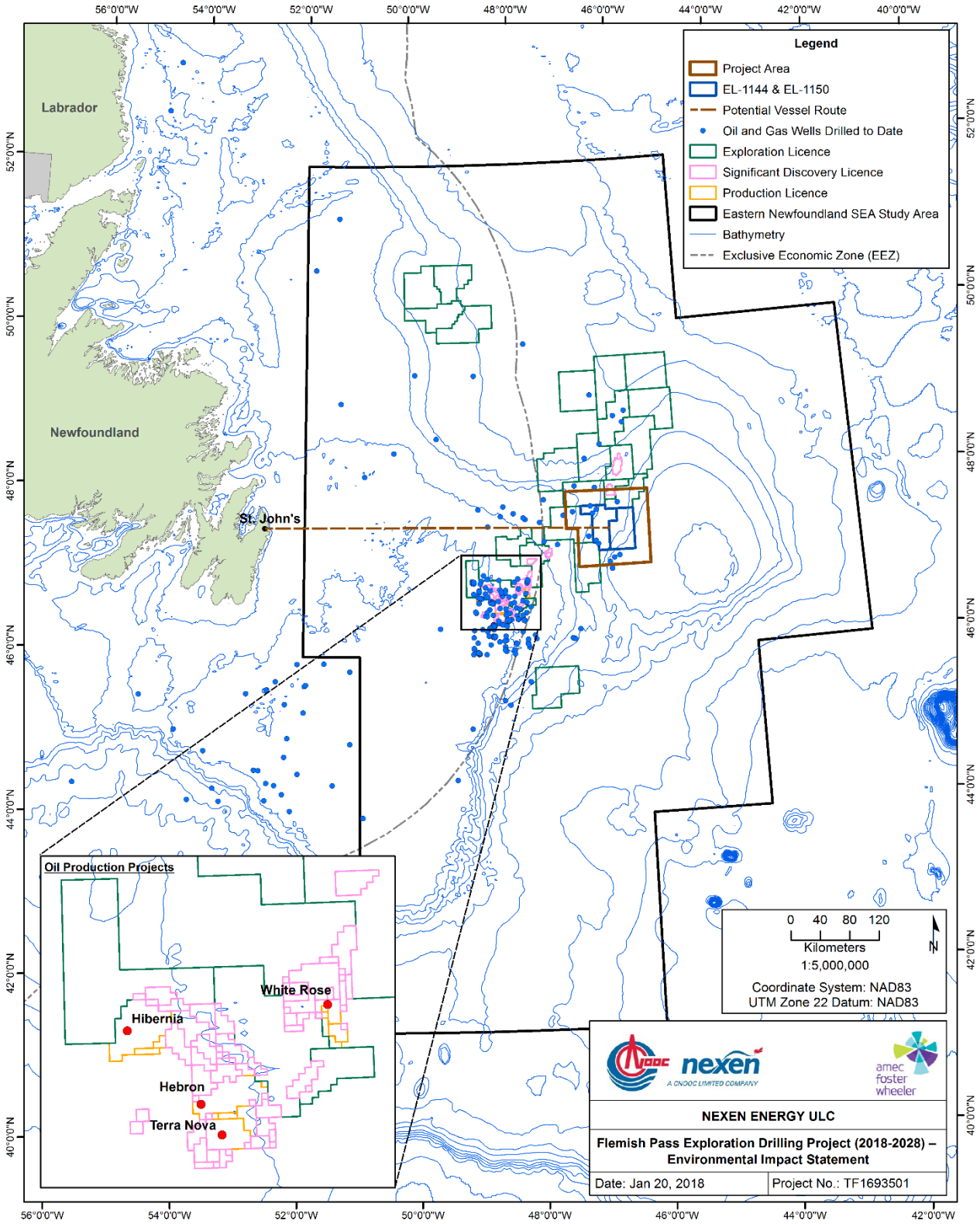
Table 7.28 Oil Production Projects off Eastern Newfoundland

Project	Overview
Hibernia Oilfield	• Discovered in 1979, the Hibernia Oilfield is operated by the Hibernia Management and Development Company Ltd. (HMDC), and is located approximately 315 km east-southeast of St. John's, NL. • The development phase of that project commenced in late 1990 and continued until the mating of the Gravity Based Structure (GBS) and its topsides at Bull Arm NL in 1997, after which the platform was towed to and installed at its site on the Grand Banks in June of that year. • With estimated recoverable reserves of approximately 1.644 billion barrels, commercial production from the Hibernia field commenced in November 1997 and is on-going. • In recent years the project has been further expanded to include the Hibernia South Extension Unit, from which production commenced in 2011.
Terra Nova Oilfield	• Discovered in 1984 and declared a significant discovery in 1985, this oilfield has reserve estimates of approximately 506 million barrels of recoverable reserves. • The Terra Nova Project is currently in operation by Suncor Energy Inc. using a floating production, storage and offloading (FPSO) vessel, and is located approximately 350 km southeast of St. John's and 35 km southeast of Hibernia. • Dry-dock construction of the Terra Nova FPSO vessel began in early 1999, and it arrived at Bull Arm in May 2000 where outfitting, hook-up and commissioning of the vessel took place. • The FPSO arrived at the oilfield in August 2001 and began producing oil in January 2002.
White Rose Oilfield and Extension Project	• Discovered in 1984, a significant discovery licence for the field was issued in January 2004. • It is located about 350 km east-southeast of St. John's, and approximately 50 km from the Hibernia and Terra Nova fields. • The White Rose oilfield and its satellite extensions are operated by Husky Energy Inc. utilizing a FPSO vessel, and first oil was produced in November 2005 followed by the North Amethyst expansion in May 2010. Estimated reserves of 480 million barrels.
Hebron Oilfield	• First discovered in 1980, this oilfield is estimated to contain more than 700 million barrels of recoverable resources. • The Hebron Platform was towed to field in June 2017. The Project is designed for an oil production rate of 150,000 barrels of oil per day. • First oil from the Hebron Project occurred in late November 2017
Source: Amec (2014); NLF (2017b)	

The Eastern Newfoundland Offshore Area is also subject to on-going and planned offshore oil and gas exploration activities. The type and amount of offshore exploration activity can vary considerably from year to year, and in particular parts of the region. Over the period 2014 to 2016 an average of approximately 390,000 km of seismic survey data (2D, 3D and other) was collected annually in the C-NLOPB's defined Eastern Newfoundland offshore region, with an average of about 35,000 undertaken annually in the Jeanne d'Arc Basin area (C-NLOPB 2017a). In addition, as of November 31, 2017 a total of 448 wells had been drilled in the overall Canada-NL Offshore Area, including 168 exploration wells, 56 delineation wells, and 223 development wells. Up to November 31, 2017 nearly 40 exploration or delineation wells were drilled in the Eastern Newfoundland land tenure area, and an additional 333 wells were drilled in the Jeanne d'Arc Basin area. To date, approximately 15 wells have been drilled in the Flemish Pass itself. C-NLOPB 2017b). Exploration activities are ongoing in the Flemish Pass, South Grand Banks, South Labrador Sea and Labrador Northeast Slope (NLF 2017b).

In 2013, Statoil announced two discoveries in the Flemish Pass Basin (Figure 7.73), immediately to the north of ELs 1144 and 1150. The Bay du Nord discovery is estimated to contain from 300 to 600 million barrels of recoverable oil and the resource potential of the Harpoon discovery is not yet fully assessed. These properties are in close proximity to the adjacent Mizzen discovery, which is estimated to contain 102 million barrels of recoverable oil (NLF 2017b).

Figure 7.73 Petroleum Exploration and Production in Eastern Newfoundland



7.3.3 Military Activities

Under the Canadian *National Defence Act*, the Department of National Defence (DND) is responsible for protection of Canada and its interests, and for contributing to international peace and security. The Canadian Armed Forces (including its navy, army and air force components) is mandated to protect Canada and defend its sovereignty through coastal and aerial surveillance. The Armed Forces are also engaged in assisting civil rescue authorities with domestic disaster relief (DND 2016a). Canada has been a member of the North Atlantic Treaty Organization (NATO) since its founding in 1949 and since that time the Canadian Armed Forces have been engaged in NATO security and peacekeeping missions throughout the world. The Armed Forces are responsible for defending North America, in cooperation with the United States, through the North American Aerospace Defense Command (NORAD), and as a NATO member, contributing to international peace and security operations around the world (DND 2016a). The Armed Forces also assist civilian organizations with Search and Rescue activities. Operations include aeronautical search and rescue, medical evacuations, ground search and rescue and provision of equipment and services to other humanitarian response efforts. The Canadian Rangers, reserve members of the Armed Forces, are also active in ground search and rescue (DND 2016a). These operations may include the coastal and marine waters off Newfoundland.

The Royal Canadian Navy (RCN) operates in Canada's oceans to guard the coast, detect suspicious and illegal activities and to respond to emergencies and disasters. Maritime Forces Atlantic (MARLANT), the RCN in the Atlantic Region, is headquartered in Halifax, Nova Scotia. Atlantic facilities include MARLANT Headquarters; Canadian Forces Base Halifax, Canadian Fleet Atlantic, a Fleet Maintenance Facility and Canadian Forces Station St. John's, NL. The RCN reservist fleet HMCS Cabot operates out of St. John's. This group is mainly responsible for coastal surveillance and patrol, including search and rescue, law enforcement and natural resource (including fisheries) protection (DND 2016a).

The RCN and Air Force operate routine surveillance and monitoring operations, often with associated training exercises. While exact locations of some activities may not be disclosed, military, training, surveillance, monitoring and rescue operations may occur throughout Atlantic Canadian waters. As a result, DND may operate aircraft or marine patrols off Eastern Newfoundland. Navy vessels may also provide support to DFO in conducting fishery patrols in Atlantic Canada, including the coastal waters and marine areas off Newfoundland (DND 2016a).

7.3.4 Unexploded Ordnances and Legacy Sites

Historically, many locations across Canada have been used for military operations, training and weapons testing. Wartime action along Canada's coasts and incidents involving ships, planes or vehicles carrying ammunition and explosives have also created "legacy sites" with remaining unexploded ordnances (UXOs). UXO shipwrecks are known sites of shipwrecks containing unexploded munitions. A UXO legacy site is any property that was owned, leased or used by DND but no longer resides within DND's inventory and for which there exists a UXO risk associated with past DND activities. Several hundred land-based UXO legacy sites are known to exist at locations across Canada. In addition, approximately 1,100 sites are known to exist in marine areas off Canada's east coast, with 26 sites on the Pacific coast (DND 2016b).

DND's UXO and Legacy Sites Program was established in 2005, with the objective of reducing safety risks posed by UXOs at legacy sites across Canada. The program identifies and catalogues sites,

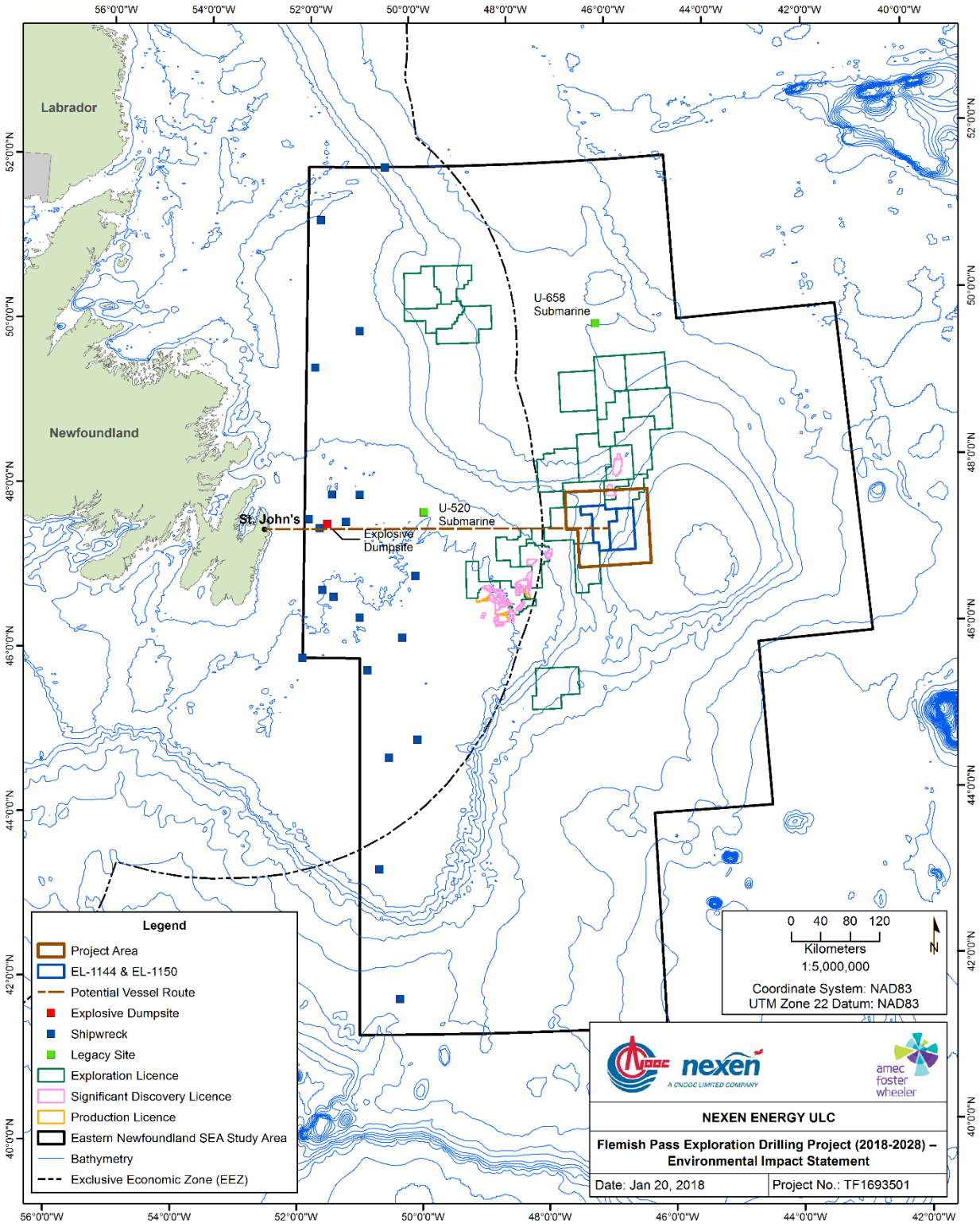
assesses risks and works to reduce UXO risk through property controls, assessment surveys, UXO clearance operations and public education. In locations where the risk is minimal, signage and information campaigns are used to alert the public to potential hazards. At sites where the potential risk is great, public safety is ensured by restricting access (DND 2016b).

Various known UXO legacy sites and shipwrecks exist within the Canada-Newfoundland and Labrador Offshore Area (DCC 2017). These include legacy sites and explosive dumpsites but the majority are shipwrecks (Table 7.29). None of these sites are located within or near the Project Area itself (Figure 7.74).

Table 7.29 UXOs and Legacy Sites

Site or Vessel Name	Type
U-520 Submarine	Legacy Site
U-658 Submarine	Legacy Site
Friar Rock	Shipwreck
Empire Celt	Shipwreck
Flynderborg	Shipwreck
Gretavale	Shipwreck
Broompark	Shipwreck
Arnish	Shipwreck
Balsam Lake	Shipwreck
Capitao Jose Vilareinho	Shipwreck
Diana	Shipwreck
Edward A. Cohan	Shipwreck
Empire Soldier	Shipwreck
Gigantic	Shipwreck
J. B. Kitchen	Shipwreck
Jean M. Madelin	Shipwreck
King Malcolm	Shipwreck
Magnhild	Shipwreck
Mount Mycale	Shipwreck
Nokomis	Shipwreck
R. Bowers	Shipwreck
Rosland	Shipwreck
Royal Edward	Shipwreck
Thomas King	Shipwreck
W. T. White	Shipwreck
Sydney Shallows	Disposal Site
Halibut Channel	Disposal Site
Source: DCC (2017); AFW (2014)	

Figure 7.74 Legacy Sites, Explosive Dumpsites and Shipwrecks of Concern off Eastern Newfoundland



7.3.5 Federal Lands, and Lands Located Outside the Province or Canada

The EIS Guidelines state that the EIS should discuss any potential Project effects on federal lands. In Canada, Crown Land is public land held by the federal or provincial governments in the name of the monarch. Most federal Crown land is located within the Canadian territories but these lands are administered by the Commissioner of Northwest Territories, Nunavut and Yukon on behalf of the Government of Canada. The remaining federally controlled lands include Indian reserves, national parks and historic sites and Canada's offshore area (GOC 2017; CEAA 2016; NRC 2016). Table 7.30 shows Canadian federal agencies that hold the largest number of properties, largest total land area and largest number of buildings. Of these agencies, Parks Canada holds 93 percent of Canada's federally controlled land and National Defence holds five percent for a total of 98 percent. This land includes approximately 30 Canadian Forces bases and stations, which are owned and operated by the Canadian army, navy or air force (CAF 2016). Canada Post, DFO and Public Services and Procurement Canada together hold 55 percent of all properties. These include a network of Canadian Coast Guard facilities and more than 1,000 small craft harbours that serve the needs of commercial fish harvesters and also other marine users. A large number of harbour facilities have been, or are intended to be, transferred to local harbour authorities but many are still owned and operated by DFO (DFO 2016f).

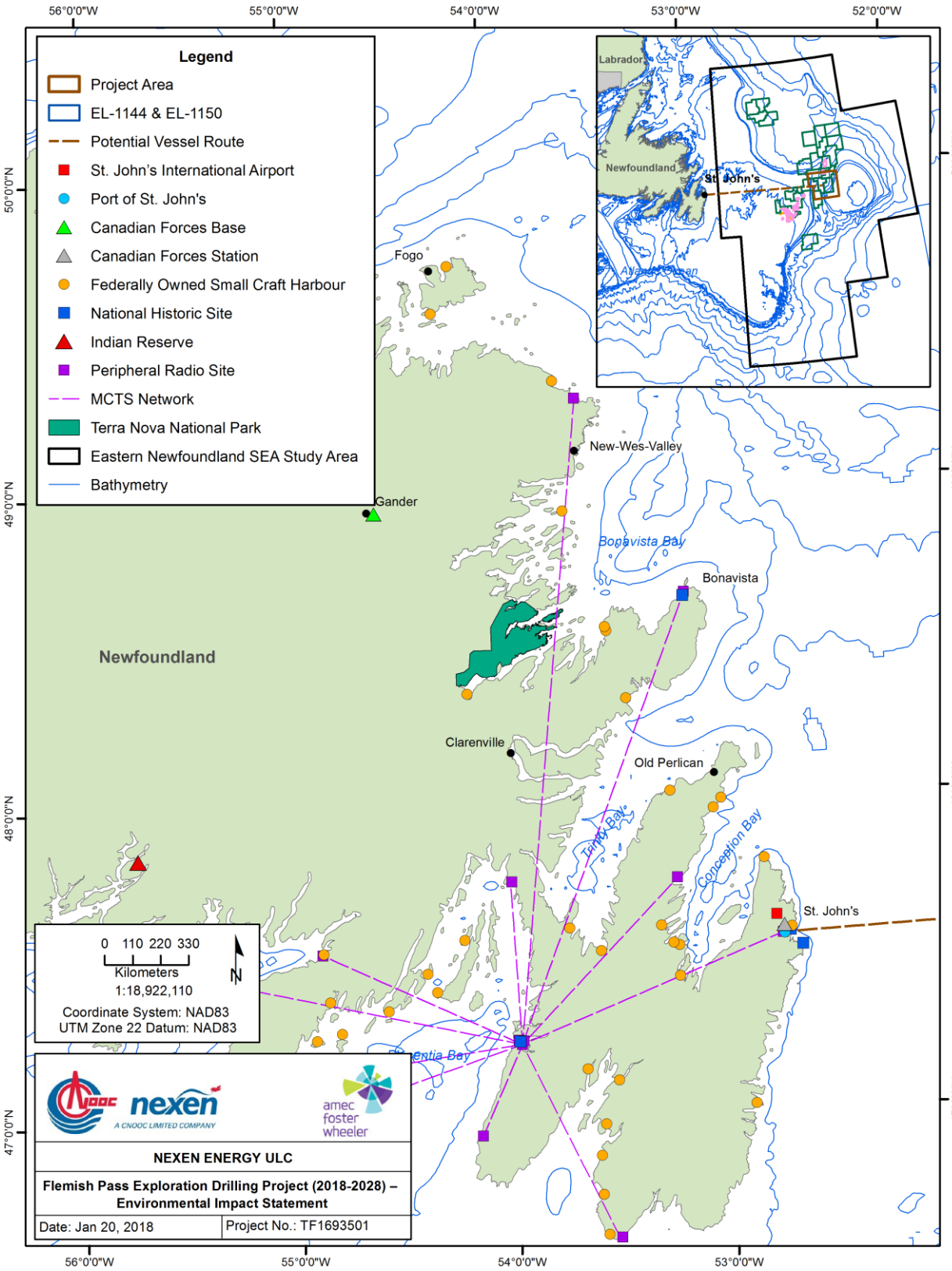
Table 7.30 Top Federal Agencies by Land Area, Number of Properties and Buildings

Organization	Land Area	Number of Properties	Number of Buildings
Fisheries and Oceans	-	5,663	-
Canada Post	-	3,018	2,933
Public Services and Procurement Canada	-	2,372	-
Parks Canada Agency	40,822,133 ha	-	3,904
National Defence	2,139,328 ha	-	13,827
Agriculture and Agri-Food Canada	456,766 ha	-	-
Canada Total	43,956,552 ha	20,234	36,633
Source: TBCS (undated)			

Various other lands and facilities fall under federal jurisdiction. These include Canada's 18 most important seaports which are governed by the *Canada Marine Act* and operated by Canada Port Authorities (CPA) at arm's length from government (TC 2017). Canada's most important airports (26 located in national, provincial and territorial capital cities and those serving more than 200,000 passengers annually) are designated as part of the National Airports System (NAS) but many have been transferred to local authorities (CAC 2017).

In Eastern Newfoundland, federal lands include National Parks and Historic Sites (as discussed in Section 6.4), Canadian Forces Station St. John's and Canadian Forces Base Gander (9 Wing), Canadian Coast Guard facilities located at Placentia along with peripheral radio sites, marine and coastal areas and Canada's exclusive economic zone (EEZ) as illustrated in Figure 7.75. Various small craft harbours owned by DFO are located in coastal areas. St. John's and gander International Airports are part of the NAS and the St. John's Port Authority is a designated CPA. No Indian Reserves are located in Eastern Newfoundland; Miawpukek Mi'kamawey Mawi'omi First Nation Reserve at Conne River on the south coast is the nearest Reserve, which is 635 km west of the Project Area. The Project Area is located outside of Canada's EEZ. A discussion of the potential effects of the Project on lands outside of the province or Canada is included in Section 18.5.

Figure 7.75 Federal Lands in Eastern Newfoundland



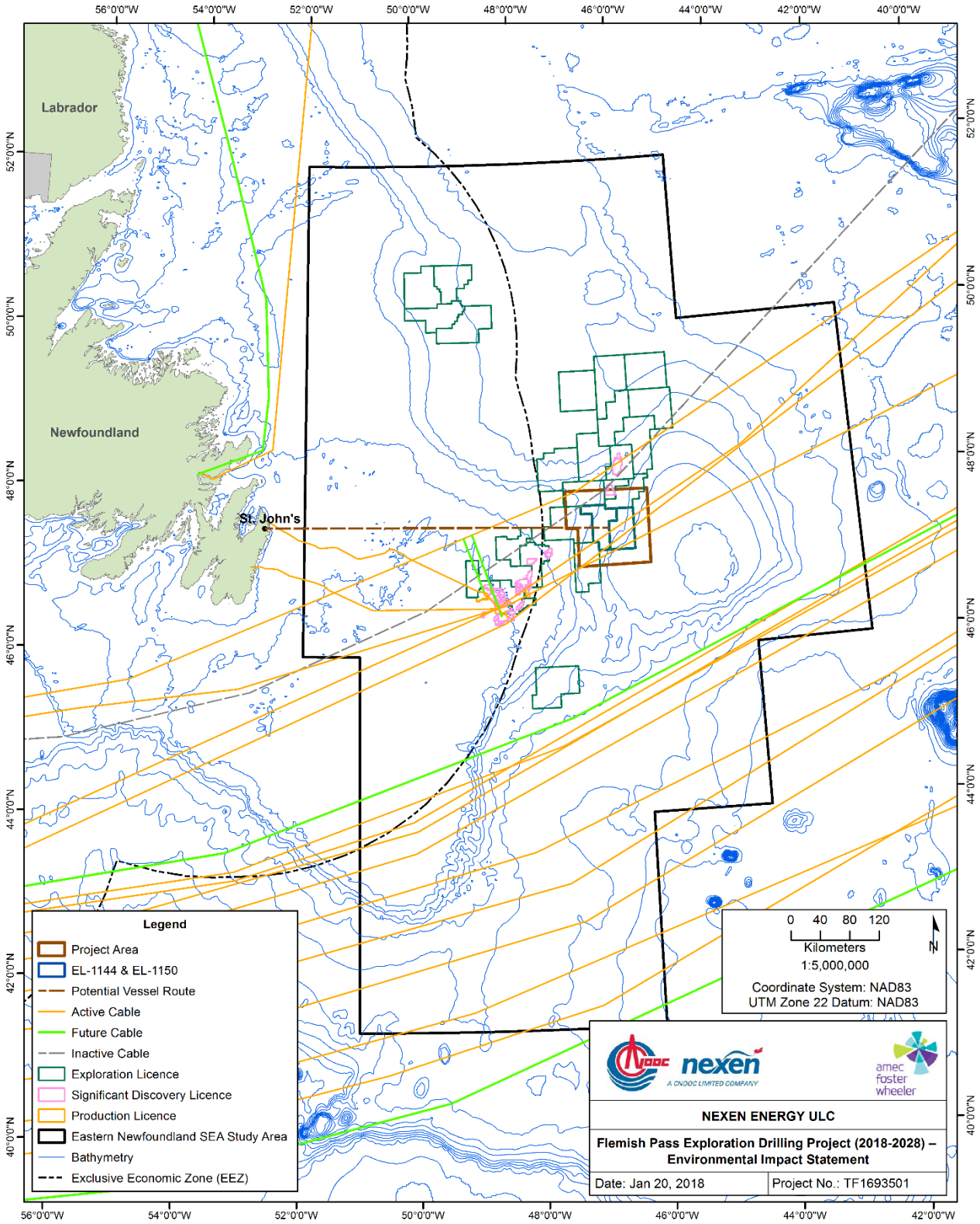
7.3.6 Subsea Cables

A number of active, abandoned and proposed marine cables transect the waters off Eastern Newfoundland (Figure 7.76) (Mahlknecht 2016; ICPC 2014; SCN 2016). In addition, HMDC and ExxonMobil Canada Properties (EMCP) have installed a fibre-optic cable communication system for the Hibernia and Hebron Projects, as well as other future projects and potentially the activities of other organizations, off Eastern Newfoundland (EMCP 2015). Four active cables intersect with the Project Area itself (Table 7.31).

Table 7.31 Marine Cables

Name	Connecting	Capacity (G)	Distance (km)	In Service	# of Lines
AC-1	USA, Netherlands, Germany, UK	120	14,301	1998	2
TAT-14	USA, UK, France, Netherlands, Germany, Denmark	3,200	15,295	2001	2
Hibernia Express	USA, Nova Scotia, Ireland, UK	1,920	12,200	2001	2
ExxonMobil	To Hibernia and Hebron Platforms	n/a	n/a	2016	2
Sources: Mahlknecht, G. (2016); SCN (2016); ICPC (2014); Teasdale, M. (2017)					

Figure 7.76 Subsea Cables in Eastern Newfoundland



7.3.7 Coastal and Marine-Based Tourism and Recreation

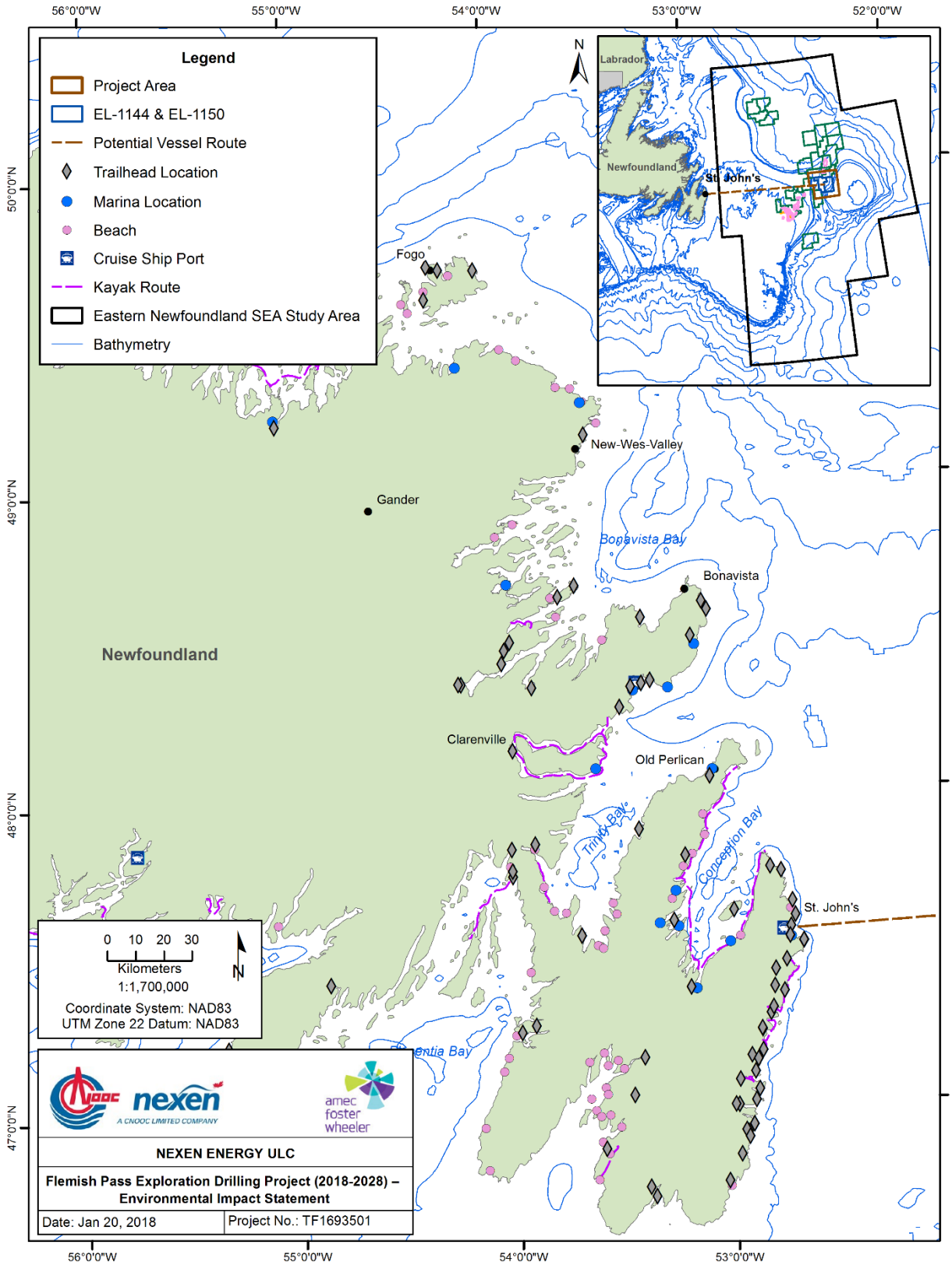
This section describes use of land and resources for the purposes of tourism and recreation by residents of Newfoundland and Labrador and visitors to the Province. Current use of land and resources for traditional purposes by Indigenous People is described in Section 7.4.

The tourism industry is a key component of the Newfoundland and Labrador economy, and includes travel by residents within the province and visiting non-residents. In 2015, an estimated 503,100 non-resident visitors spent an estimated $493 million in Newfoundland and Labrador (NLBTCRD 2016). Tourist attractions include marine-based activities that may be located in national and provincial parks that protect and exhibit areas of ecological, natural heritage, cultural and/or recreational importance in coastal areas (as described in Section 7.3.8). In Eastern Newfoundland, tourism activity generally occurs primarily within a four-month period (June to September) with the peak months being July and August. Winter activities are also popular in certain areas, and business and convention travel, which has well-developed infrastructure and facilities in the region occurs year-round.

Eastern Newfoundland has many kilometres of coastline where marine-based recreational activities occur on the open ocean and in sheltered bays (Figure 7.77). Boat tours and sea kayaking, which are among the most commonly offered tours, are clustered in five main areas: 1) Twillingate/Fogo Island; 2) Terra Nova National Park; 3) Trinity Bight; 4) St. John's and 5) the Southern Shore (Bay Bulls/Witless Bay/Mobile/Cape Broyle). Coastal hiking trails include the East Coast Trail, which extends 275 km along the east coast of the Avalon Peninsula from Cape St. Francis to Cappahayden. Marinas are located throughout coastal Newfoundland, including St. John's, Long Pond, Holyrood, Bay Roberts, Harbour Grace, Port de Grace and Old Perlican on the Avalon Peninsula. Coastal amenities also include beaches, campsites, RV trailer parks and picnic sites (MA 2014; NLT 2017). None of these tourism and recreation amenities and activities are located in or near the Project Area itself.

Eastern Newfoundland has a number of noteworthy bird habitats, including coastal sites that may be used for bird watching (Figure 7.77). These areas may be completely or partially protected by federal (e.g.,Terra Nova National Park) or provincial parks and protected areas (Cape St. Mary's Ecological Reserve, Baccalieu Island Ecological Reserve, Funk Island Ecological Reserve, Mistaken Point Ecological Reserve, Witless Bay Ecological Reserve and Lawn Islands Archipelago Provisional Ecological Reserve). Public access to some ecological reserves is by permit only. Protected areas and identified sensitive marine bird habitats (that may be used for bird watching) are also discussed in Section 6.4. None of these sites are located within or near the Project Area.

Figure 7.77 Select Coastal and Marine-Based Tourism Sites in Eastern Newfoundland



Each year from May to October, Newfoundland and Labrador ports are visited by large cruise ships on trans-Atlantic routes and small ships that tour the province and elsewhere in Eastern Canada. In 2016, a total of 22 cruise ships made 66 port calls to 22 Newfoundland and Labrador ports, resulting in a total of 33,933 passenger visits. Thirty-two of these port calls were by cruise ships that sail around Newfoundland and Labrador, Saint-Pierre, the Maritimes and Quebec meaning that they did not cross the Atlantic Ocean (and therefore, the Project Area) (CNL 2016). In 2016, Eastern Newfoundland ports of call included St. John's, Trinity Bay and Twillingate (Table 7.32). September was the busiest month for cruise ships with 15 port calls (Table 7.32). St. John's is the main port-of-call and the beginning and/or end of tours for several small cruise ships that visit ports in Newfoundland and Labrador, Saint-Pierre-et-Miquelon and/or Eastern Canada. In 2016, some of the cruise ships visiting Eastern Newfoundland crossed the Atlantic Ocean: seven entered or exited from Greenland, four through Ireland and two via the United Kingdom. Based on the 2016 itineraries, most cruise ships are not likely to cross the Project Area.

Table 7.32 Eastern Newfoundland Cruise Ship Activity (2016)

Month	Port(s) Visited	Ships
May	St. John's	2
June	St. John's	5
	Trinity Bay	1
July	St. John's	2
August	St. John's	1
September	St. John's	12
	Eastern Newfoundland	2
	Twillingate	1
October	St. John's	1
Total		27
Source: CNL (2016)		

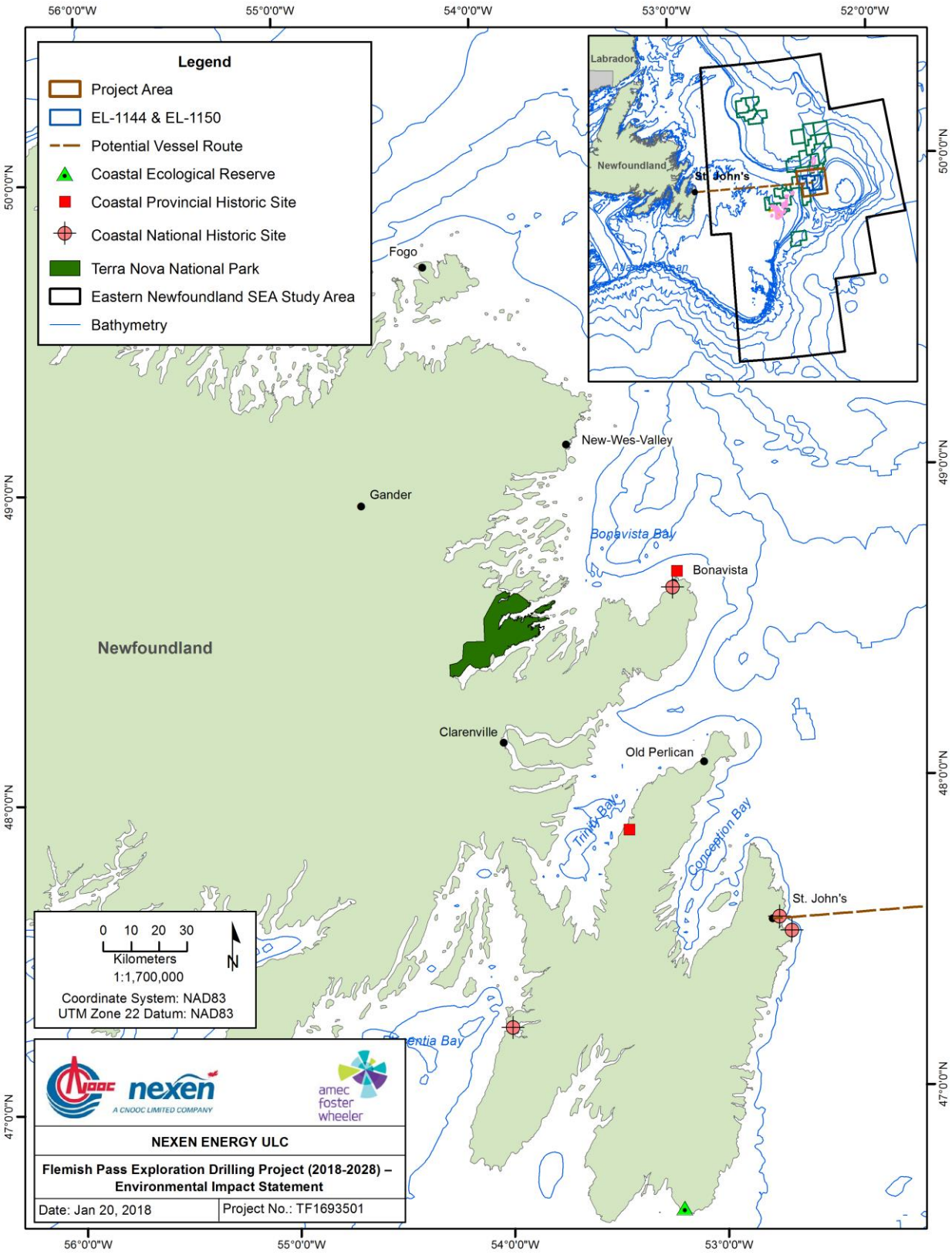
7.3.8 Physical and Cultural Heritage

Newfoundland and Labrador has a number of provincial and national historic sites, and those in Eastern Newfoundland are discussed further in Section 6.4.

The province has a total of more than 5,000 discovered archaeological sites, which are all protected under the *Historic Resources Act* even if undisclosed or undeveloped. These sites are related to various cultures: Maritime Archaic Indian, Palaeoeskimo, Intermediate Indian, Recent Indian, Beothuk, M'kmaq, Inuit, Innu and European. Other areas of high heritage resource potential have been identified throughout the province including shipwrecks in coastal waters.

More than 900 known archaeology sites are located in Eastern Newfoundland and many are in coastal areas (M. Drake pers comm 2017). Although there are known sites along the eastern coastline of the Island of Newfoundland and elsewhere along the province's coasts, there are no known heritage resources located in or near the Project Area itself or along the associated vessel traffic route.

Figure 7.78 Coastal Natural and Cultural Heritage Sites in Eastern Newfoundland



7.3.9 Recreational Hunting and Gathering

This section describes hunting for recreational and subsistence purposes by residents of or visitors to Newfoundland and Labrador. Current use of land and resources for traditional purposes by Indigenous people is discussed in Section 7.4.

In the marine environment, hunting includes harvesting a range of mammals, waterfowl and seabirds. The recreational groundfish fishery and seal hunt are described in Section 7.2.7, with the following section describing hunting for waterfowl and seabirds in Eastern Newfoundland. Residents may also gather shellfish such as clams and mussels in coastal areas, but specific and detailed information is not available on where, when and how much of these resources are harvested.

In Canada, bird hunting is regulated under the *Migratory Birds Convention Act*, 1994 and *Migratory Birds Hunting Regulations*. Environment and Climate Change Canada provides annual hunting regulations, including season dates and bag limits for each province and territory (CWS 2016). The particular species hunted in marine and inland areas differ by province, region and habitat type. Residents of Newfoundland and Labrador hunt various migratory bird species in marine and inland areas. These birds (including species of waterfowl and murres) have long been an important source of food in traditional diets.

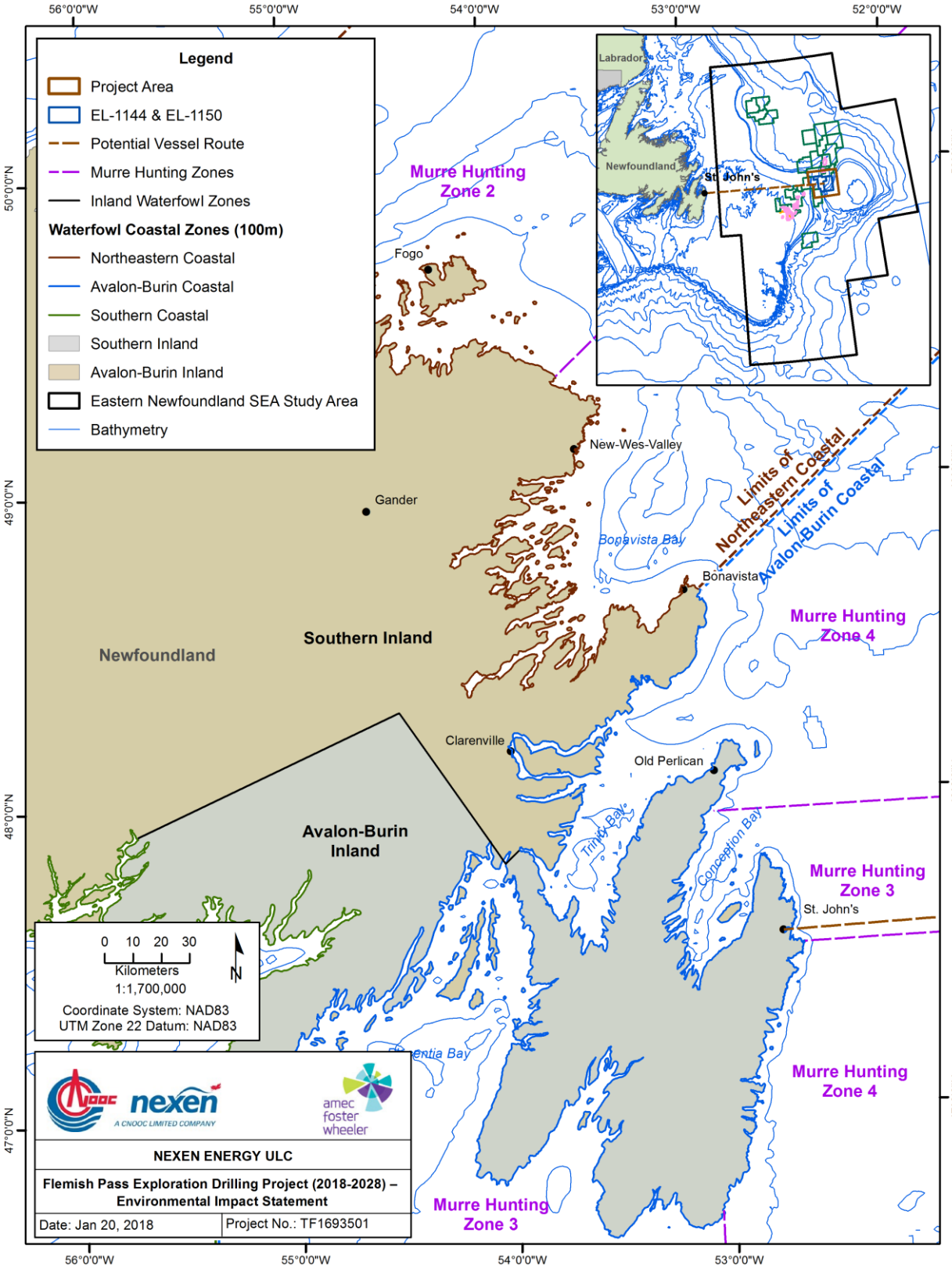
The Eastern Newfoundland Offshore Area includes the Northeastern Coastal and Avalon – Burin Coastal Migratory Game Bird Hunting Zones, as well as Murre Hunting Zones 2, 3 and 4 (Figure 7.79). Coastal areas of Eastern Newfoundland have fall/winter hunting seasons, which vary depending on the species (Table 7.33). There are no spring/summer waterfowl or murre hunting seasons in Eastern Newfoundland (CWS 2016). Bird hunting activities are conducted in nearshore areas.

Table 7.33 Waterfowl and Murre Hunting (2016-2017)

Bird Type	Species	Management Area	Fall/Winter Seasons	Daily Bag / Possession Limit
Waterfowl	Ducks	Northeastern Coastal/Avalon – Burin Coastal	September 17 to December 31, 2016	6/18 (with other limitations)
	Mergansers			6/12
	Geese			5/10
	Snipe			10/20
	Long-tailed Ducks, Eiders and Scoters		November 25, 2016 to March 10, 2017	6/12
Murres (Turrs)		Hunting Zone 2	October 6, 2016 to January 20, 2017	20 per hunter per day/40 per hunter at any one time
		Hunting Zone 3	November 25, 2016 to March 10, 2017	
		Hunting Zone 4	November 3, 2016 to January 10, 2017/February 2 to March 10, 2017	
Source: CWS (2016)				

Information is not available on the exact location, number of hunters and the consumption of waterfowl and seabirds in Eastern Newfoundland.

Figure 7.79 Waterfowl and Seabird Hunting Areas off Eastern Newfoundland



7.4 Indigenous Peoples

This section provides information related to Indigenous groups in Newfoundland and Labrador, Nova Scotia, New Brunswick, Prince Edward Island and Québec as outlined in Section 5.1 of the EIS Guidelines (Table 7.34; Figure 7.80).

Table 7.34 Indigenous Groups in Eastern Canada Included in the EIS Guidelines

Province	Indigenous Groups
Newfoundland and Labrador	Labrador Inuit (Nunatsiavut Government)
	Labrador Innu (Innu Nation)
	NunatuKavut Community Council
	Miawpukek First Nation
	Qalipu Mi'kmaq First Nation Band
Nova Scotia	11 Mi'kmaq First Nation groups represented by Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO):
	- Acadia First Nation
	- Annapolis Valley First Nation
	- Bear River First Nation
	- Eskasoni First Nation
	- Glooscap First Nation
	- Membertou First Nation
	- Paqtnkek Mi'kmaw Nation
	- Pictou Landing First Nation
	- Potlotek First Nation
	- Wagmatcook First Nation
	- Waycobah First Nation
	Millbrook First Nation
	Sipekne'katik First Nation
New Brunswick	Eight Mi'gmaq First Nations groups represented by Mi'gmawe'l Tplu'taqnn Inc. (MTI)
	- Fort Folly First Nation
	- Eel Ground First Nation
	- Pabineau First Nation
	- Esgenoôpetitj First Nation
	- Buctouche First Nation
	- Indian Island First Nation
	- Eel River Bar First Nation
	- Metepnagiag Mi'kmaq First Nation
	Elsipogtog First Nation
	Five Maliseet First Nation groups represented by Wolastoqey Nation of New Brunswick (WNNB):
	- Kingsclear First Nation
	- Madawaska Maliseet First Nation
	- Oromocto First Nation
	- Saint Mary's First Nation
	- Tobique First Nation
	Woodstock First Nation
	Peskotomuhkati Nation at Skutik (Passamaquoddy)
Prince Edward Island	Abegweit First Nation
	Lennox Island First Nation

Province	Indigenous Groups
Quebec	Three Mi'gmaq First Nation groups represented by Mi'gmawei Mawiomi Secretariat (MMS)
	- Micmas of Gesgapegiag
	- La Nation Micmac de Gespeg
	- Listuguj Mi'gmaq Government
	Les Innus de Ekuanitshit
	Montagnais de Nutashkuan

The sections that follow provide socioeconomic baseline information for each of the above noted Indigenous Groups. This includes providing a brief overview of the background and current socioeconomic conditions of each group, including each of the items specified in the EIS Guidelines and/or required under Section 5(1)(c) of CEAA 2012, specifically:

- Health and socio-economic conditions
- Physical and cultural heritage
- Current use of lands and resources for traditional purposes, and
- Structures, sites or things of historical, archaeological, paleontological or architectural significance

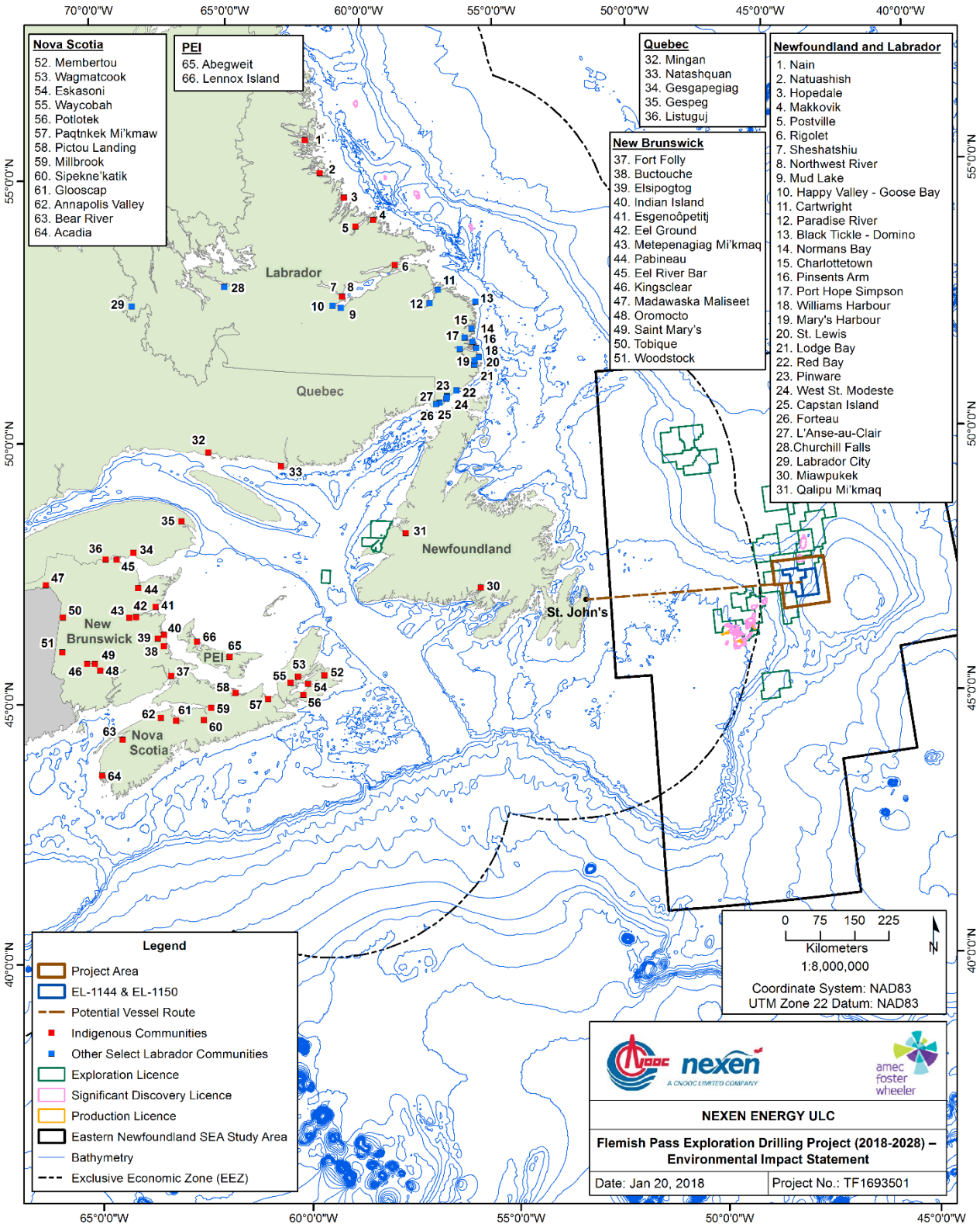
The existing environment description that follows focusses primarily on those socioeconomic components with potential for Project-related interactions and effects (see Sections 4.2 and 12.2) , in particular any current use of (marine-associated) lands and resources for traditional purposes.

The description of other socioeconomic components is provided primarily for background and context, and to address the above noted requirements, but is comparably brief and structured for brevity.

7.4.1 Overview of Food, Social and Ceremonial (FSC) and Commercial-Communal Fishing

The following background information is presented to describe the evolution of the current administration of Indigenous Food, Social and Ceremonial (FSC) and commercial-communal fishing rights by DFO in Eastern Canada. The 1990 *Sparrow* judgment of the Supreme Court of Canada (SCC) determined that Indigenous peoples have the right to fish for FSC purposes, independent of any treaty, provided that certain criteria are met. This Aboriginal right has priority over other fishing practices, but it is subject to conservation policies related to species and habitat conservation. In 1992, DFO created the Aboriginal Fisheries Strategy (AFS) to provide a co-management framework for fishing by Indigenous groups, pursuant to which communal fishing licences for FSC purposes are issued. A component of the AFS is the Allocation Transfer Program, whereby commercial fisheries quotas are transferred to Indigenous groups (DFO 2012b). Following a review of the AFS, DFO created the Indigenous Aquatic Resource and Oceans Management (AAROM) program in 2003, to provide funding to Indigenous organizations to develop administrative, scientific and technical expertise for aquatic resource and oceans management (Charest et al 2012).

Figure 7.80 Indigenous Communities in Eastern Canada



The 1999 *Marshall* decision of the SCC recognized the treaty rights of Mi'kmaq (this spelling has been used for general discussions in this report with the appropriate spelling used in proper names), Maliseet and Passamaquoddy First Nations, in Nova Scotia, Prince Edward Island, New Brunswick and the Gaspé region, to harvest and sell fish in a manner that ensures a moderate livelihood, and noted that those rights are communal (INAC 2010). It should also be noted that where treaty-based commercial-communal fishing licences have been granted to a community by DFO, a right to fish exists, regardless of whether that right is exercised.

In 2000, DFO created the Marshall Response Initiative (MRI) to finance increased Indigenous participation in commercial fisheries. In 2007, the MRI was replaced by the Atlantic Integrated Commercial Fisheries Initiative (AICFI) to provide mentoring and training to build commercial fisheries capacity in Mi'kmaq and Maliseet communities in New Brunswick, Prince Edward Island, Nova Scotia and the Gaspé region (UDG 2016). These initiatives have increased commercial fishing capacity for First Nations by providing access to licences, equipment, mentoring and training.

The MRI and AICFI initiatives have supported the development of a professional Indigenous fishery, however communities have varying levels of capacity. A number of Indigenous organizations work with the Mi'kmaq and Maliseet First Nations to develop fisheries capacity. For example, the Ulnooweg Development Group (UDG) was established in 1986 to provide loans and business services to Indigenous entrepreneurs in Atlantic Canada. The UDG Business Development Team, which works collaboratively with the Atlantic Policy Congress (APC) of First Nations Chiefs Secretariat and DFO, is a service provider for Indigenous Groups that wish to establish sustainable businesses in the Atlantic commercial fishery (UDG 2016; Johnstone 2014). The discussions of current use of land and resources for traditional purposes includes information on FSC and commercial-communal fishing licences. It should be noted that while many of the Indigenous groups hold such fishing licences, in many cases it is unclear if and where such fishing occurs.

Fishing is one of most important cultural and economic activities of Indigenous Groups residing in Eastern Canada. Fishing is an important component of community revenue and seafood is an important traditional food and is essential to diet and good health. As discussed in the following subsections related to particular groups, Indigenous peoples have a spiritual relationship to the plants, animals and fish they harvest for food and ceremonial purposes and sharing food with extended family and community is a traditional cultural practice.

7.4.2 Key Information Sources

A variety of existing and available information sources were used to understand and describe the various Indigenous peoples and communities listed above, including: available land claims documentation, government documents and data and community websites. In addition to these sources, publicly available reports and studies were accessed and used as relevant. The primary source of information on FSC and commercial-communal fishing activity is DFO. Thus, these data do not include information on fishing activity that may occur by individual Indigenous people. Data and information on demographic characteristics were obtained from Indigenous and Northern Affairs Canada (INAC) and Statistics Canada (SC). Some data from the 2016 census are rounded or suppressed for confidentiality due to the small populations involved. Where limited information was available on particular aspects such as community health or land and resource use in the Indigenous communities, more general information has been provided if available.

7.4.3 Newfoundland and Labrador Indigenous Groups

Newfoundland and Labrador Indigenous groups include: Labrador Inuit, Labrador Innu, NCC, Miawpukek First Nation and the Qalipu Mi'kmaq First Nation Band (Table 7.35; Figures 7.81 and 7.82) The following sections provide community profiles for each Indigenous group.

Table 7.35 Newfoundland and Labrador Indigenous Communities and Organizations

Indigenous Group	Community / Group	Lands / Reserve(s)	Representative Organizations
Labrador Inuit	Hopedale, Makkovik, Nain, Postville, Rigolet	Labrador Inuit Settlement Area, Inuit Communities (Northern Labrador)	Nunatsiavut Government
Labrador Innu	Mushuau Innu	Labrador Innu Land Claims Area / Natuashish Reserve	Mushuau Innu First Nation / Innu Nation
	Sheshatshiu Innu	Labrador Innu Land Claims Area / Sheshatshiu Reserve	Sheshatshiu Innu First Nation / Innu Nation
NunatuKavut Community Council	Cartwright, Charlottetown, Forteau, L'Anse au Clair, Pinware, Port Hope Simpson, Mary's Harbour, Red Bay, St. Lewis, Subdivision 10A (Capstan Island), Subdivision 10B (Black Tickle-Domino, Lodge Bay, Norman's Bay Paradise River, Pinsent's Arm, Williams Harbour)	NCC Land Claims Area (Labrador)	NunatuKavut Community Council
Mi'kmaq	Miawpukek	Samiajij Miawpukek	Miawpukek First Nation Band
Mi'kmaq	Qalipu Mi'kmaq	None	Qalipu Mi'kmaq First Nation

Figure 7.81 Indigenous Communities in Labrador

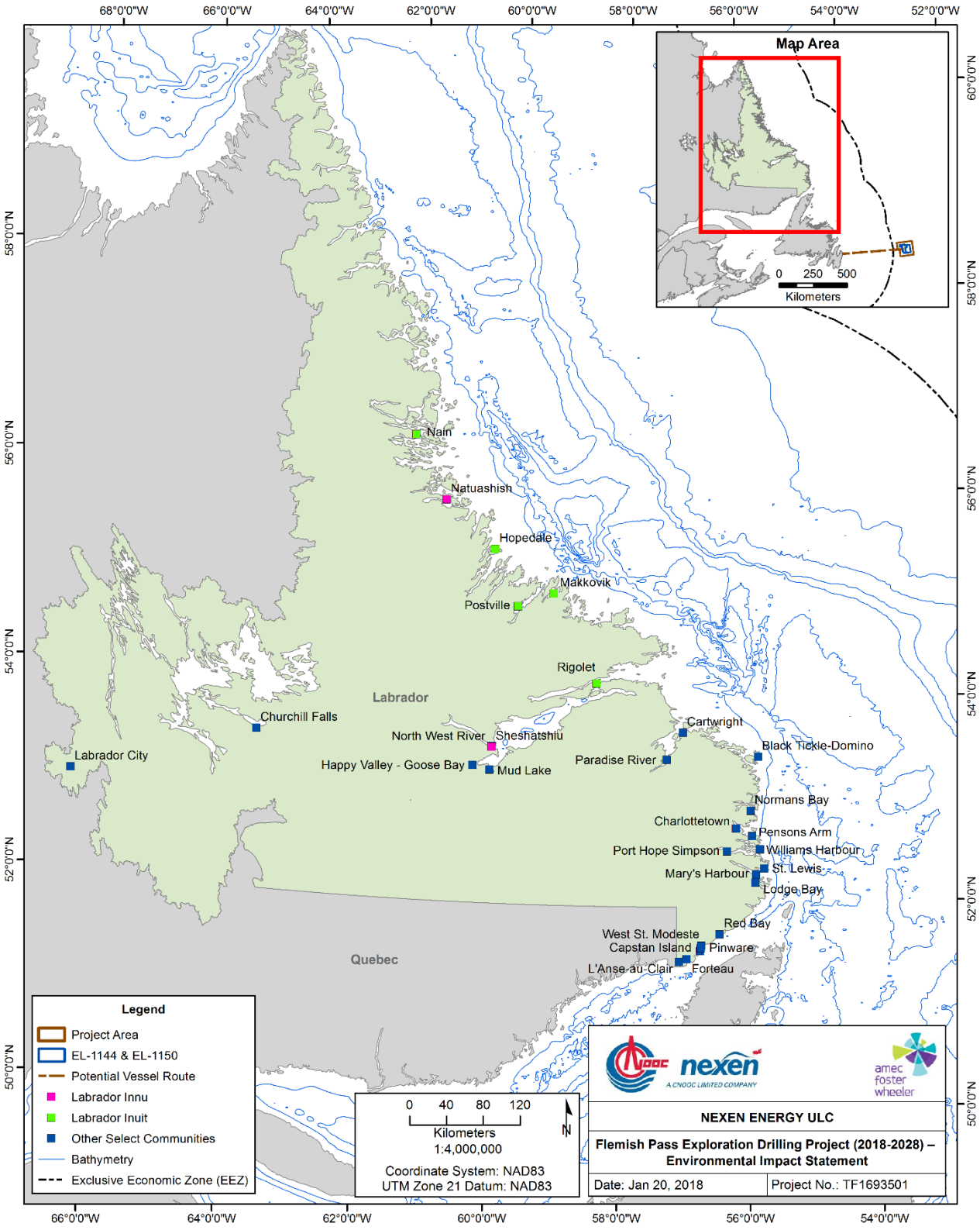
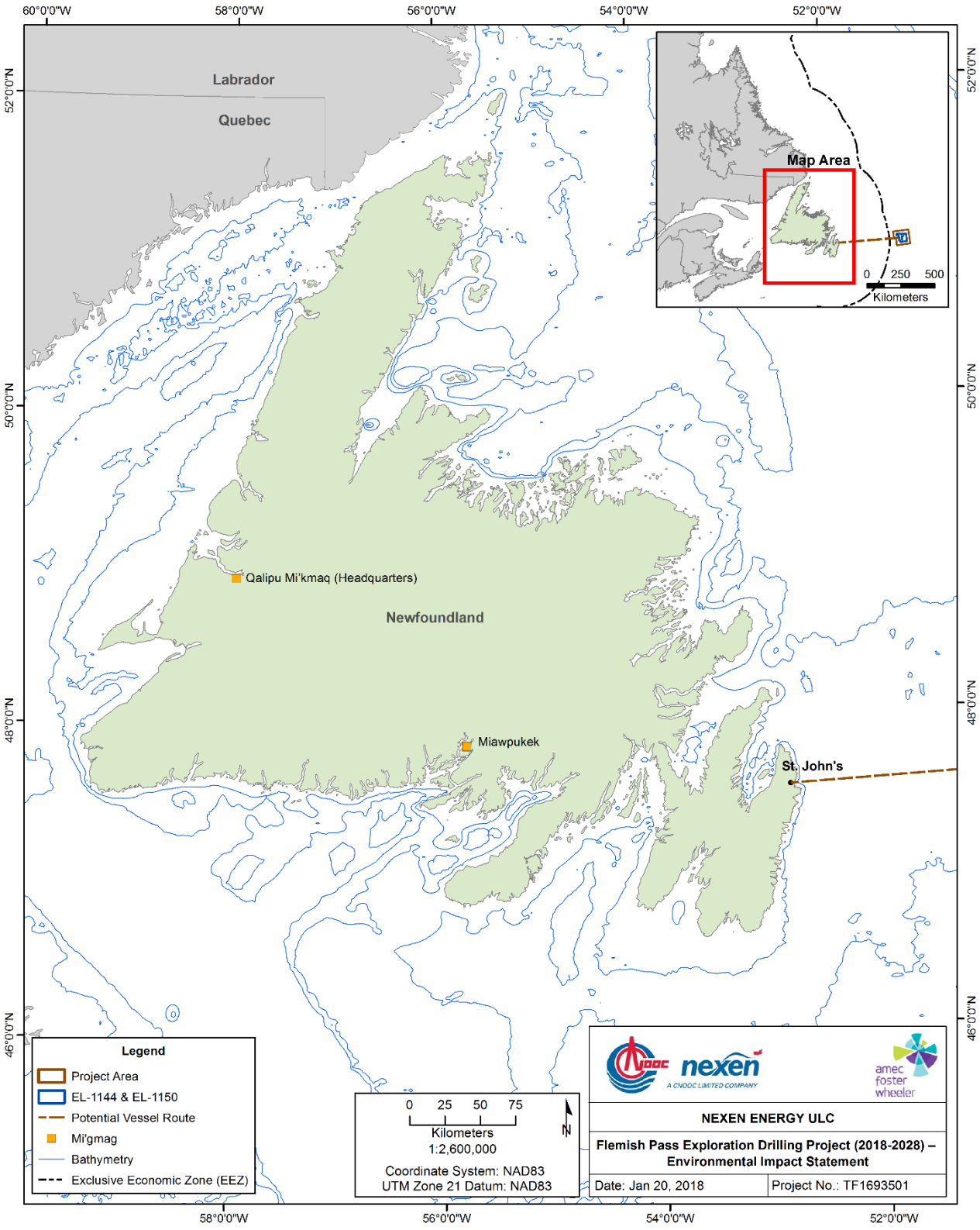


Figure 7.82 Indigenous Communities in Newfoundland



7.4.3.1 Labrador Inuit (Nunatsiavut Government)

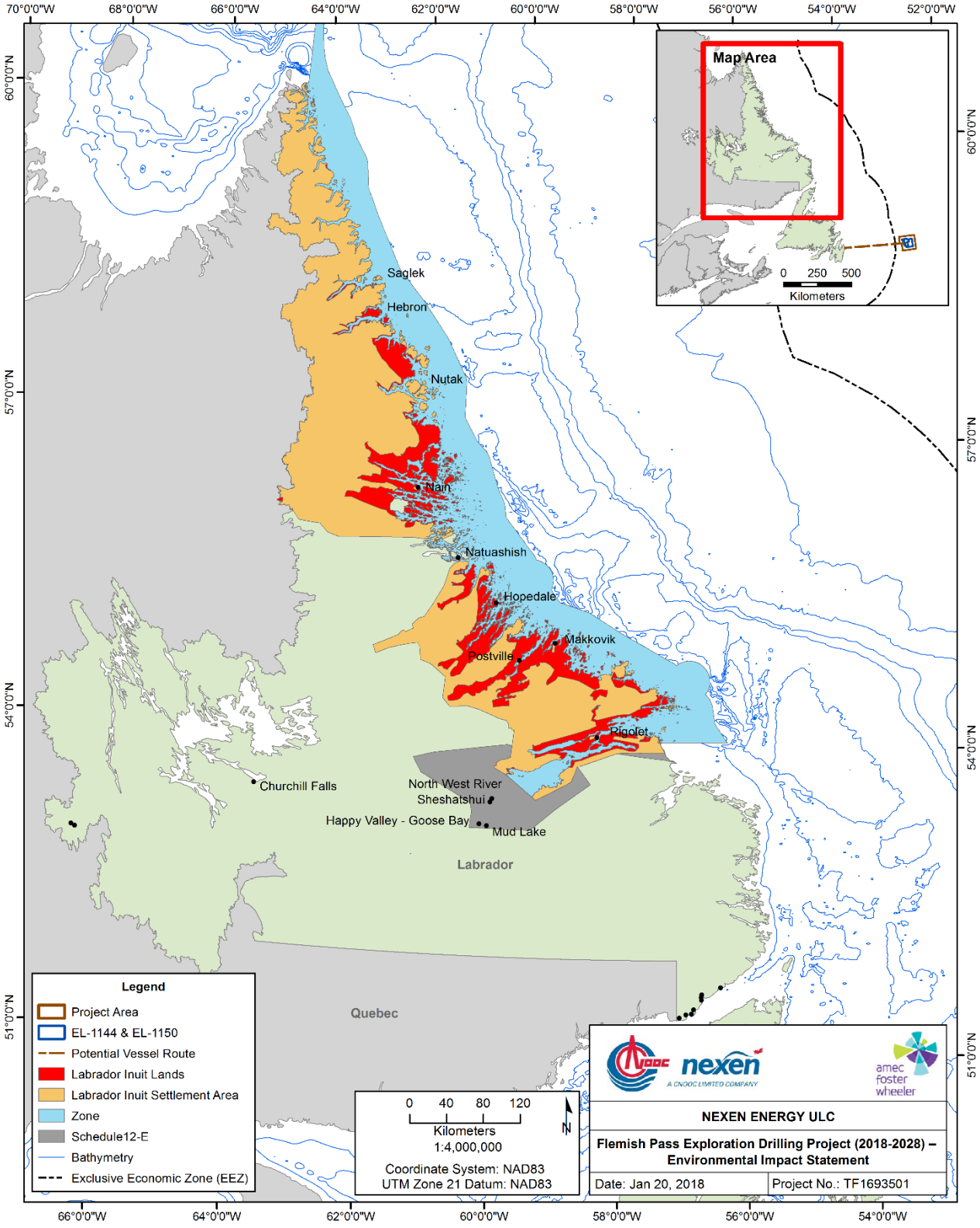
The Labrador Inuit whose traditional territory extends from Cape Chidley in the north, to south of Groswater Bay and west to the Labrador-Québec border (Figure 7.83) are descendants of the pre-historic Thule people (Nalcor Energy 2011; Nunatsiavut Government 2017). They are culturally and linguistically part of the Inuit peoples who occupy the Arctic and parts of the sub-Arctic, from Alaska east across northern Canada, Greenland and the Arctic edges of the former Soviet Union, and are the most southerly expansion of this culture (VBNC 1997).

The Nunatsiavut Government currently represents more than 6,000 Labrador Inuit beneficiaries living in the five Inuit communities of Nain, Hopedale, Makkovik, Postville and Rigolet (Nunatsiavut Government 2017; SEM 2011). The current populations of the individual Labrador Inuit communities are not provided by INAC so data from the 2016 census are used to describe these populations. Some of these Inuit communities are experiencing population growth while others have declined. The population of Hopedale and Makkovik increased between 2011 and 2016. The populations of Nain, Postville and Rigolet decreased during the same period. The population of most of the Labrador Inuit communities is relatively young as the percentage of population under 15 years of age (between 18 and 23 percent) is higher and the median age (31 to 41.2 years) is lower than that of the Newfoundland and Labrador population in general (i.e., 14.3 percent and 46 years, respectively) (SC 2017).

The Nunatsiavut Government, an Inuit regional self-government, was established following three decades of land claims negotiations between the Labrador Inuit Association (LIA) and the Governments of Canada and Newfoundland and Labrador. The *Labrador Inuit Land Claims Agreement* (LILCA), which came into effect in 2005, outlines land ownership, resource-sharing, self-government and delivery of programs and services within the Labrador Inuit Settlement Area (LISA), and provides for harvesting rights within and outside of the LISA in interior, coastal and offshore areas of northern Labrador (Figure 7.83). The LISA is comprised of approximately 72,500 km² of land in northern Labrador of which, 48,690 km² is within the Labrador Sea. The LILCA is a modern, comprehensive treaty and a land claims agreement in keeping with Sections 25 and 35 of the Canada *Constitution Act, 1982*. The LILCA gives the Nunatsiavut Government power and authority including administration, control, development, conservation and management of Labrador Inuit Lands (LIL) (15,799 km²). The Agreement also established implementing bodies including the Torngat Joint Fisheries Board, Torngat Wildlife and Plants Co-Management Board and Torngat Secretariat (Nalcor 2011; INAC 2017).

The Nunatsiavut Government also includes two Inuit Community Corporations that represent members living outside of the LISA, in the Nunatsiavut Assembly. These are the NunaKatiget Inuit Community Corporation that serves beneficiaries residing in Happy Valley-Goose Bay (HVGB) and Mud Lake and the Sivunivut Inuit Community Corporation serving beneficiaries residing in North West River and Sheshatshiu (Nalcor Energy 2011).

Figure 7.83 Labrador Inuit Land Claims Area



Current Use of Lands and Resources for Traditional Purposes

The pre-contact Inuit lifestyle included harvesting during all seasons for food, clothing, shelter and tools and seasonal migration to follow the movements of the animals and fish upon which they depended (Nalcor Energy 2011). European immigration and establishment of Moravian missions at Nain, Okak, Hopedale and Hebron beginning in 1771, was followed by dramatic and lasting changes in traditional Inuit culture, settlement and subsistence patterns (VBNC 1997). In the late 19th century and early part of the 20th century, Inuit became increasingly involved in the market economy and adapted new practices to earn income from industries focused on trapping and seal hunting, as well as fishing for cod, char and salmon (Nalcor Energy 2011).

The Labrador Inuit undertake current land and resource use activities on their traditional lands within the LISA, which include hunting for birds, seals, rabbits, caribou and moose and fishing and trapping (Nalcor Energy 2011). Traditional food has important value beyond market criteria, because its cultural, social and nutritional qualities are an integral part of the Inuit lifestyle (Usher 1976, in VBNC 1997). According to a 2008 Inuit health survey, more than 75 percent of respondents had an active hunter in the home and 80 percent shared their traditional foods food with others in the community (Egeland 2010). Seventy-five percent reported that they would prefer to eat more traditional food than they could currently obtain due to various limitations (i.e., no hunter in the home, no snowmobile or boat and high cost of supplies) (Egeland 2010).

Study participants reported that they consumed the following traditional foods: fresh caribou meat (consumed by 98.1 percent of participants); berries (by 93.5 percent); Arctic char (by 93.1 percent); caribou ribs (by 84 percent); caribou marrow (by 72.5 percent), partridge (by 68.7 percent); dried caribou meat (by 66.8 percent); rock ptarmigan (by 66.8 percent); Canada goose (by 65.3 percent); and caribou heart (by 62.6 percent). Recreational and subsistence land use and harvesting activities include: hunting for seals, birds, rabbits, caribou and moose; fishing; ice fishing; trapping; travelling by boat, snowmobile, snowshoes, dog team, foot, truck, plane and helicopter; berry-picking; prospecting; and gathering firewood (Egeland 2010; SEM 2009).

The Labrador Shelf area is extensively fished for crab, rock cod, cod, Arctic char, sculpins, mussels, clams, winkles and sea urchins (SEM 2008). Fishing activity is well dispersed throughout the Labrador Shelf Area. Capelin is harvested for food within coastal waters around Hopedale, Postville, Sandy Beach and Rapid Point area (Brice-Bennett 1977, in SEM 2008).

Although there is no commercial salmon fishery, an Indigenous traditional fishery for Atlantic salmon exists in Labrador. In 2012 approximately 14,200 salmon (36 tonnes) were harvested by Labrador Indigenous Groups (DFO 2015b) (see Section 12.3 for a discussion of the specific populations used).

FSC Fishing

The Nunatsiavut Government (Labrador Inuit) holds FSC fishing licences. Salmon, trout and Arctic char may be harvested throughout the LISA. These three species as well as smelt and seal may be harvested in the Upper Lake Melville Area (Ball, 2017 pers comm; Statoil 2017). As per the LILCA (Chapter 13 – Fisheries Chapter of the Agreement), Beneficiaries have the right to harvest at any time of the year throughout the LISA for any species or stock of fish or aquatic plant, up to the quantity needed for their food, social and ceremonial purposes (Ball, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

The Nunatsiavut Government currently holds a number of commercial-communal fishing licences. Groundfish licences are held for NAFO Divisions 2GHJ, 3KL and Greenland halibut may be harvested in 2+3K, 3LMNO and 0B. Seal licences permit harvesting in Sealing Areas 4 through 33, which includes all of Atlantic Canada. Scallop licenses have been issued for Scallop Area 1 off the coast of Northern Labrador. Snow crab licences include Snow Crab Areas 1 and 2 (Lake Melville Area) as well as an Exploratory licence for NAFO 2H (Northern Labrador). Northern shrimp licences are held for Shrimp Areas 4 and 5 (Central Labrador). The group also has an Arctic char licence for the area from Cape Rouge to Cape Chidley in Northern Labrador (Ball, 2017 pers comm; Statoil 2017).

Bird Harvesting

The Labrador Inuit traditionally harvest migratory birds including eider and black ducks, ptarmigan/grouse, Canada goose, murres, mergansers, scoters and loons (SEM 2008). Important areas for migratory birds, along the north coast of Labrador, include areas from north of Hopedale to Davis Inlet, Island Harbour Bay, Tunungayualok Island, Mugford Tickle to Cape Kiglapait, Okak Bay, Tasiuyuk Bay, Napartok Bay to Kangalaksiorvik Fjord, Kaipokok Bay, White Bear Island, Hare Islands, Windsor Harbour south the Byron's Bay, Turnavik Islands area, Ailik Islands, Cape Makkovik, Island Harbour Bay, Dunn's Island, Adlavik and Ironbound Islands, Jako's Bight, Makkovik Bay, Jeanette Bay, Groswater Bay and Back Bay (Brice-Bennett 1977, in SEM 2008).

Other important bird areas and surrounding waters used by the Labrador Inuit for traditional hunting activities include the waters and islands of the Backway, Table Bay and St. Peter's Bay where sea ducks are hunted, and the waters of Point Amour where sea ducks and murres (also called turrs) are harvested (Intervale Associates Inc. 2012).

Migratory birds are an important part of Labrador Inuit harvest. A total of 5,468 birds are reported as being harvested in 2006-2007 (Natcher et al 2011). According to the Inuit, Canada goose, black duck, common eider, surf scoter, black scoter and white-winged scoter were most abundant and most extensively harvested by Inuit hunters. Also during this time, the Inuit harvested a total of nearly 10,000 eggs, with common eider eggs representing 36 percent of the total harvest, followed the eggs of gulls (32 percent), terns (20 percent) and common guillemots (12 percent) (Natcher et al 2012). A perceived decline in the availability of migratory bird eggs was noted during the survey, and attributed to the relative absence of capelin, cod, sculpin and other species upon which the migratory birds feed (Natcher et al 2012).

Marine Mammal Harvesting

The Northwest Atlantic harp seal is harvested for subsistence purposes by Inuit in Labrador, Arctic Canada and Greenland. Approximately 80,000 seals are harvested annually for subsistence, with the majority being harvested from Greenland, where the harp seal migrates for the summer (DFO 2014b). Labrador Inuit harvest seals within Hamilton Inlet and Lake Melville (Brice-Bennett 1977, in Nalcor Energy 2011) and in Back Bay, Head of Groswater Bay, Black Island, Island Harbour Bay, Jako's Bight, Makkovik Bay, Adlavik Bay, Saglek Fjord and Kanairiktok Bay (Brice Bennett 1977, in SEM 2008).

Ringed seals are hunted for subsistence purposes in the early spring. Important harvesting areas include locations from Hare's Ears and The Highlands to Back Bay, Groswater Bay in The Channel area, Double Mer, areas around Drunken Harbour Point and the Advalik Islands, Napartok Bay, Hebron Fjord, Saglek Fjord, Kangalaksiorvik Fjord, Okak Bay, Tasiuyak Bay, Mugford Bay, Anchorstock Bight, Aulatsivik Island area, Tunungayualok Island, Nain Bay, Voisey's Bay, Tikkoatokak Bay, Webb Bay, Anaktalak Bay, areas around Hopedale, Flowers Bay to Island Harbour Bay, and the Turnavik Islands (Brice-Bennett 1977, in SEM 2008).

Following the ice break-up in spring, the Inuit hunt or net harp seals as well as ringed, harbour, grey and bearded seals in the outer island areas and in the bays as the seals move with the tide (VBNC 1997). Important harbour seal hunting areas include Tunungayualok Island and area, Shoal Tickle, Big Bay, Flowers Bay, Kikkektak and Ivjogiktok Islands, Okak Bay, Tasiuyak Bay, Amitok Island, Illuviktalik Island, Iglusuaktaliak Island, Tikkigaksuk Peninsula, Napartok Bay, Seal Bight, Cod Bag Harbour, Shark Gut Harbour, Saglek Fjord, Kaipokok Bay, Big Brook, Jeanette Bay (including Sandy Cove), and Jako's Bight (Brice-Bennett 1977, in SIM 2008). Grey seal hunting occurs in areas around Tunungayualok Island and near Tasiuyak Bay (Brice-Bennet 1977, in SEM 2008).

Other Socioeconomic Components

The Labrador Inuit communities are small and remote and various services are provided in the communities and in larger regional centres. The communities are accessible for most of the year by air and sea. Regional airlines provide regularly scheduled service. Coastal communities are serviced by ferries operated by the Government of Newfoundland and Labrador in the ice-free season and Labrador Winter Trails grooms public trails to a number of communities in the winter months. The following table summarizes the available information on socioeconomic conditions.

Table 7.36 Socioeconomic Overview of the Labrador Inuit Communities

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Community governments and regional agencies provide infrastructure and services such as schools, policing, firefighting, drinking water, recreation, health care, home care, health promotion, healing and mental health services. • Common health problems included heart disease, diabetes, high blood pressure, cancer and high cholesterol. • The Inuit communities have commercial fisheries. In addition, seafood	• In Inuit culture, "land" includes adjacent sea ice and the relationship with the marine environment is crucial to their way of life as land and sea are often barely distinguishable in winter. • Landfast ice is considered as much a part of Inuit life as the land.	• The earliest known ancestors of the Labrador Inuit lived primarily along the north coast and travelled all over northern Labrador to harvest resources. • Following establishment of Moravian missions and trading posts in the 18th and early 19th centuries, the Inuit became settled in communities. • Nearly 800 known Inuit and Thule archeological sites are located in coastal and inland areas from the Northern tip of Labrador to southern Labrador at the Québec border and on the

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
processing plants are located in Nain and Hopedale. • Other industries include public administration, health care and social assistance, mining and tourism. • Major employers are the Nunatsiavut Government, Labrador Inuit Development Corporation, Inuit Community Governments, the Voisey's Bay Mine/Mill near Nain.		Northern Peninsula of Newfoundland.
Sources: Nunatsiavut Government (2017); NLPAO (2017); Nunatsiavut Government (2013); Town of Postville (2003); Torngasok (2013); Nalcor Energy (2011); Egeland (2010); Fugman (2010); Town of Hopedale (2005); VBNC (1997)		

7.4.3.2 Labrador Innu (Innu Nation)

The Innu are Indigenous inhabitants of an area they refer to as Nitassinan, which includes much of the Québec-Labrador Peninsula. The Innu were traditionally a nomadic people, whose movements responded to the seasons and to the migrations of the animals, such as caribou, they relied upon. (AFW 2014; INAC 2017).

The current population of the Labrador Innu reside primarily in two communities – Sheshatshiu and Natuashish. Sheshatshiu, which is located in Central Labrador, was formerly part of the community of North West River. In 1979, the Innu formed a separate community, which is now the Sheshatshiu First Nation Reserve with an elected Chief and Band Council. Natuashish is located 300 km north of HVGB on the Labrador North Coast and is only accessible via plane or boat. The community was founded in 2002, following the Innu's relocation from the previous community at Utshimassit (Davis Inlet). Natuashish is also a Reserve with an elected Chief and Band Council (INAC 2017).

The Labrador Innu had a total Registered First Nations population of more than 2,700 in October 2017. Approximately 90 percent of the Registered population of these First Nations lives on the Sheshatshiu and Natuashish Reserves. Small numbers of Innu also reside in HVGB, Labrador and elsewhere. The Sheshatshiu Innu and the Mushuau Innu of Natuashish are represented by Innu Nation of Labrador in land claims negotiations and on other matters of common interest (INAC 2017).

In 2016, the median age of the population of both First Nations (~21.5 years) was less than half of that of the province in general (46 years) and the percentage of individuals below 15 years of age in Sheshatshiu (36.3 percent) and Natuashish (40.1 percent) was three times higher than the provincial

population (14.3 percent). This means that the birth rate is higher in these communities but Natuashish experienced little growth between the 2011 and 2016 census.[4]

The Innu of Labrador claim Aboriginal rights and title to much of Labrador and parts of Québec. In 1978, the Labrador Innu land claim was accepted for negotiation by the Government of Canada. Following the completion of an Innu land use and occupancy study, formal negotiations with the governments of Canada and Newfoundland and Labrador began in 1991. A self-government framework agreement was signed in 1996 and ratified in 1997. In 2008, the Government of Newfoundland and Labrador and Innu Nation announced the signing of the *Tshash Petapen* (translated as "New Dawn") *Agreement*, which resolved key issues relating to matters between the Provincial Government and Innu Nation related to the Innu land claim, as well as impacts and benefits related to past and proposed hydroelectric developments in Central and Western Labrador.

Since that time, the three parties have completed detailed agreements on these matters, including a *Labrador Innu Land Rights Agreement-in-Principle* (AIP), which was signed by the Innu in 2011. Under the *Tshash Petapen Agreement*, particular areas of Labrador have been designated as Labrador Innu Lands (LIL, Category 1), Labrador Innu Settlement Area (LISA, Category 2), Permit-Free Hunting Area (Category 3) or other designated lands under the current Labrador Innu land Claims AIP (Figure 7.84). The current Labrador Innu Land Claim AIP is not legally binding, and forms the basis of on-going treaty negotiations that will result in a Final Agreement (Labrador and Aboriginal Affairs Office, Undated; AFW 2014; AANDC 2016; INAC 2017).

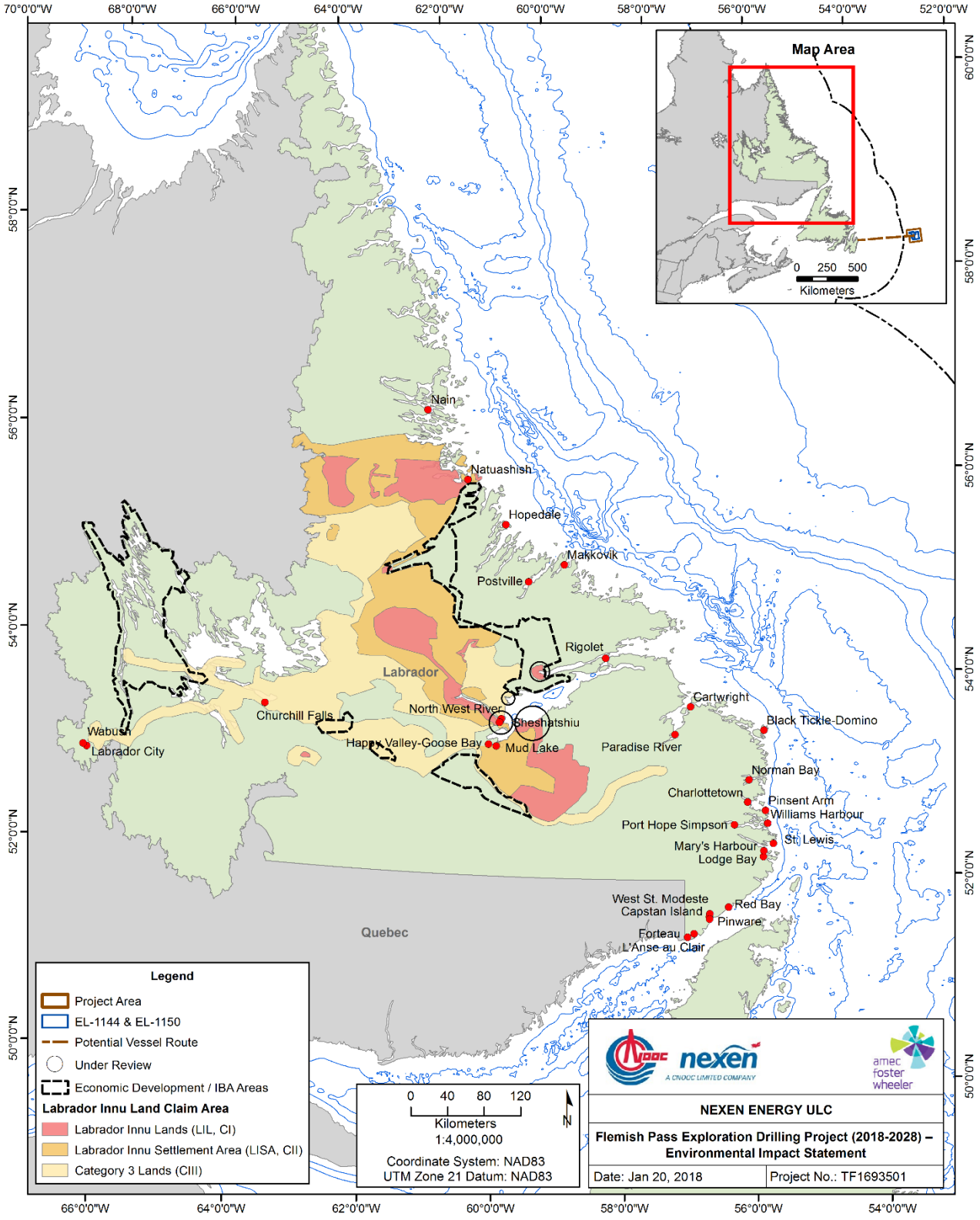
Current Use of Lands and Resources for Traditional Purposes

This section focuses on the current use of lands and resources for traditional purposes by the Labrador Innu. As stated, the Innu were traditionally a nomadic people, but following the establishment of Innu settlements in the 1960s, traditional land use and harvesting practices changed considerably. Although somewhat limited information is publicly available, there is slightly more information available related to Sheshatshiu Innu land use. For instance, due to the existence of a permanent settlement in Sheshatshiu, women and children began to remain in the community for most of the year and men spent less time on the land hunting and trapping (Nalcor Energy 2011). Nonetheless, the Sheshatshiu Innu continued to harvest a range of resources including caribou, black bear, small game and fish, in a relatively wide-ranging area not necessarily restricted to the lands and waterways surrounding the community (MacLaren Plansearch 1994, in Nalcor Energy 2011).

An Outpost Program was established in the 1970s to help finance travel by Innu families to and from camps in the interior of Labrador and to enable Innu to travel into the country as an educational opportunity and community activity and to practice their traditional activities (VBNC 1997). In a 1997 study, approximately 42 percent of the Innu Nation population, that participated in the survey, indicated that they partake in country-based harvests year-round. Spring is the most active season, with 48 percent of participants spending at least one week on the land hunting, fishing and gathering wild foods (Nalcor Energy 2011).

[4] The Sheshatshiu population data are to be interpreted with caution due to high non-response rates to the short-form and long-form census questionnaires (SC 2017).

Figure 7.84 Labrador Innu Land Claims Area



The core areas traditionally used by Sheshatshiu Innu are the headwaters of Eagle River; the area bounded by Winnokapau Lake, Smallwood Reservoir, Seal Lake and Nipishish Lake, Shipiskan Lake, Snegamook Lake and Shapio Lake and parts of Québec. More recently, Labrador Innu have also harvested along the Trans Labrador Highway (TLH) between HVGB and western Labrador. Various travel routes such as roads, snowmobile trails, walking trails, canoe and motorboat routes used by Labrador Innu have been recorded in southern Labrador, with a relatively high number of travel routes near the TLH between Churchill Falls and HVGB and near Lake Melville (Armitage 2010, in Alderon Iron Ore Corp 2012). Given its location, the Project is not likely to interact with Labrador Innu use of land or resources, including travel corridors, for traditional purposes.

FSC Fishing

Innu Nation holds FSC fishing licences for Sheshatshiu and Natuashish. The Sheshatshiu licence includes salmon, trout and Arctic char in the area from Fish Cove Point north to Cape Harrison (between Rigolet and Postville), including Lake Melville and the inland waters of Little Lake and Grand Lake. The Natuashish FSC licence permits harvesting salmon, trout and Arctic char in all tidal waters of Labrador extending north and east from Cape Harrigan inclusive of Big Bay and south and east of Anaktalik Bay inclusive of Anaktalik and Anaktalik Bays and the inland waters of Sango Pond and Big Sango Lake (Ball, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

The Labrador Innu are engaged in commercial-communal fishing enterprises. Innu Nation holds licences for groundfish in NAFO 0, 2GHJ, 3KL, groundfish (mobile gear) in NAFO 2GHJ, 3KL, mackerel and capelin in Fishing Areas 1 to 11 (northern Labrador to Burgeo) and shrimp in Shrimp Area 4, which is roughly from Rigolet to Postville. Ueushuk Fisheries Limited holds a mid-shore groundfish licence for various areas. This provides for harvesting a variety of species, including Greenland halibut in NAFO 2+3K, 3LMNO and 0B; skates in 3LNO and in 3Ps, 4X, 5Y, 5Z (j,m) with by-catch permitted in several other areas; white hake in 3NO and 3Ps with by-catch permitted in other areas; Atlantic halibut in NAFO 3NOPs and 4VWX+5Zc with a science quota and a competitive reserve in other areas; and haddock in 5Z (j,m) with by-catch permitted in other areas. Ueushuk Fisheries also holds a shrimp licence for Shrimp Areas 6 and 7, which include areas from southern Labrador to southwest Newfoundland (Ball, 2017 pers comm; Statoil 2017).

Bird Harvesting

The Innu hunt goose and duck near the TLH west of Churchill Falls, along the Churchill River and near Dominion Lake (Armitage 2010 and MacLaren Plansearch 1994, in Alderon Iron Ore Corp. 2012). Migratory waterfowl have been hunted around Crooks Lake and Parke Lake in southeastern Labrador, the shoreline of Lake Melville, along several roads between HVGB and Sheshatshiu, on the south side of the Churchill River at Gull island, the Eagle River plateau, the Mud Lake / Upper Lake Melville area and near Sheshatshiu and North West River (Armitage and Stopp 2003; Armitage 2010 and MacLaren Plansearch 1994, in Alderon Iron Ore Corp 2012).

Important bird areas and surrounding waters are known to be used by the Labrador Innu as part of their traditional hunting areas and include the waters and islands of the Backway, Table Bay and St. Peter's Bay which are used for sea duck and murre hunting. The waters of Point Amour are used for sea duck

and murre hunting. Eider ducks, murres and other species harvested around the Labrador Shelf are an important source of food for Indigenous people (Intervale Associates Inc. 2012).

Marine Mammal Harvesting

Although there is limited publicly available information, it is understood that Innu hunt seals in coastal areas in the spring, summer and fall (VBNC 1997).

Other Socioeconomic Components

Sheshatshiu and Natuashish are relatively small communities that offer particular services and infrastructure to their members and residents. Sheshatshiu is located in close proximity to the regional service centre of (HVGB) and relies upon services and infrastructure in the larger community. The following table summarizes available information on socioeconomic conditions in these communities, again as general background.

An Innu Business Development Centre was created to establish businesses and contribute to Innu communities. Innu Nation has invested in a diverse range of businesses including: accommodation and food services, aircraft services, arts, entertainment, recreation, automotive, construction, engineering, waste management, forestry, geotechnical, industrial, technology and communications and tourism. Most of these business are in construction and industrial supply (Nalcor Energy 2011).

Table 7.37 Socioeconomic Overview of Labrador Innu Communities

Community	Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
Sheshatshiu	• The Band Council and other agencies provide infrastructure and services such as a school an arena/community recreation facility, policing and health care. • The RCMP and Health Canada have established a Sheshatshiu Crisis Intervention Team. Labrador Grenfell Regional Health and Sheshatshiu Innu Health Commission operate a community health clinic. More	• Labrador Innu culture and heritage is focused on their relationship to game animals most especially caribou, which is the focus of their philosophical and religious beliefs.	• Nearly 500 Innu archaeological sites are known to be located throughout Northern, central and Western Labrador. • The identified sites are located in inland and coastal areas and were often discovered in relation to developments such as communities, roads, railway and mining areas.

Community	Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
	serious cases are transported to HVGB by ambulance. • Health issues include diabetes, youth mortality, teenage pregnancy and Fetal Alcohol Spectrum Disorder. The Innu of Sheshatshiu and Natuashish have developed the Innu Healing Strategy. • Sheshatshiu Innu First Nation Band Council is the major employer.		
Natuashish	• The Band Council and other agencies provide infrastructure and services such as a school, recreation programs, policing, firefighting and health care. Patients are transported by medevac to the appropriate referral centre as required. • Employers include the Mushuau Innu First Nation Band Council, Mushuau Innu Health Commission, Mushuau Innu General Store, and Natuashish Hotel.		
Sources: Heritage Newfoundland and Labrador (2017); NLPAO (2017); Innu Education (2014); Nalcor Energy (2011); Nalcor Energy (2011); Labrador-Grenfell Regional Health Authority (2007(a)). Labrador-Grenfell Regional Health Authority (2007(b)); Tanner (1977)			

7.4.3.3 NunatuKavut Community Council

The NunatuKavut Community Council (NCC, formerly the Labrador Métis Nation) reports a membership of over 6,000 persons who reside primarily in southeastern and central Labrador and who are descendants of Inuit and Europeans who traveled to Labrador several centuries ago as seasonal fishers and whalers. Initial contact between the Labrador Inuit and Europeans was based on trade as the first European trading post was established in North West River in 1743-1744. Intermarriage between the Labrador Inuit and European fur traders resulted in a generation of people of mixed descent who were born as early as 1775. Over time the population grew, and settlements were established throughout Central and Southern Labrador (Nalcor 2010; NCC 2013).

The NCC's membership live throughout Labrador and elsewhere, particularly in the communities along the southeast coast from Hamilton Inlet south to the Labrador Straits, including the towns of Cartwright, Charlottetown, Port Hope Simpson, St. Lewis and Mary's Harbour and the communities of Paradise River, Black Tickle-Domino, Norman Bay, Pinsent's Arm, Williams Harbour and Lodge Bay, as well as in Central and Western Labrador and elsewhere (Martin et al 2012). In 2017, the residents of Williams Harbour voted to accept a provincial government resettlement package (DMAE 2017).

Census data are not available specifically for NCC members as a group. In 2016, the population of these communities ranged from 15 or fewer to 427, with five communities (Paradise River, Pinsent's Arm, William's Harbour, Norman Bay and Lodge Bay) having fewer than 100 people. Where data are available, the median age is somewhat comparable to, or higher than, the provincial population in general.

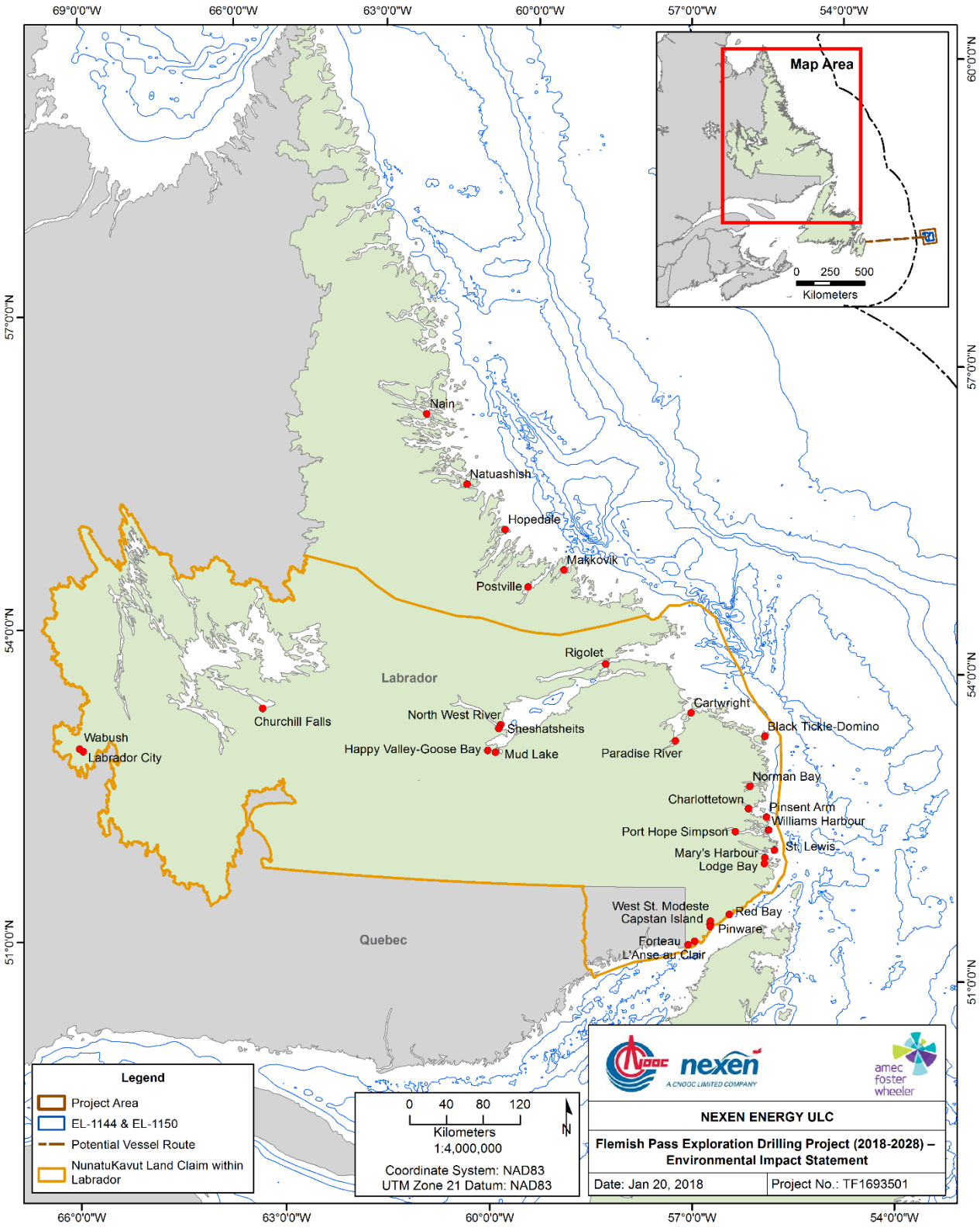
The NCC has asserted a land claim that covers much of Central, Southeastern and Western Labrador (Figure 7.85). This claim has not been accepted for negotiation by the federal or provincial governments.

Current Use of Lands and Resources for Traditional Purposes

Members of the NCC place a high importance on traditional foods, both in terms of their nutritional attributes and their cultural value (Martin et al 2012). The people continue to rely upon the resources of the land, water and sea, and are known to undertake land and resource use activities throughout Southern Labrador. They use the land in several ways as expressed through their movement along the overland and aquatic travel corridors, meeting in community gathering places, the establishment of habitation sites, trapper tilts and seasonal and permanent settlements (NCC 2010, in Nalcor Energy 2011).

In 2014, the Iron Ore Company of Canada (IOC) gathered information from NCC members in Labrador West regarding their current land and resource use activities. Information gained from this study indicates that NCC members living in that region currently undertake a variety of land and resource use activities including hunting (i.e., big game, small game and waterfowl), trapping, fishing, ice fishing, cutting firewood and saw logs, collecting berries and medicinal plants, camping, boating, snowmobiling and ATV use. These activities occur throughout the Western Labrador region, including areas adjacent to Labrador City and Wabush as well as at other locations along the TLH, roadways, the railway and snowmobile trails, near the Smallwood Reservoir and elsewhere. NCC members have cabins in Labrador West and around the Smallwood Reservoir but a larger number of cabins and tilts are located in Central Labrador near their communities of origin (AFW 2014).

Figure 7.85 NunatuKavut Community Council Land Claims Area



In this data collection exercise, 53 percent of Labrador West NCC members (of the 30 who participated in the survey) reported consuming traditional foods weekly. Species consumed include: moose, caribou, bear, ptarmigan, grouse, hare, ducks, geese, porcupine, beaver, muskrat, squirrel, salmon, cod, trout, seal, partridgeberries, blueberries, bakeapples, black currants, red currants and squash berries. It should be noted that marine species (e.g. cod, salmon, seal) are not available in Labrador West and thus are harvested in coastal areas (AFW 2014).

A 2012 land use study also showed that members of NCC travel on the land and sea by truck, snowmobile, boat, foot, dog-team and snowshoes. Use of automobiles is currently the main mode of travel for accessing land use areas. In addition, NCC members use a network of snowmobile trails connects North West River, Happy Valley-Goose Bay, Mud Lake and Churchill Falls with other communities in Labrador, including Labrador City, Wabush and Cartwright. These roads and trails are used by many Labrador residents, both Indigenous and non-Indigenous, for travel as well as to access land and resource use areas (NCC 2010b; AIOC 2012).

FSC Fishing

The NCC holds FSC fishing licences for a variety of species. A licence for salmon, trout, Arctic char, Atlantic cod, rock cod, herring, scallop, whelk, smelt and seal is held for a Coastal Area from Fish Cove Point to Cape Charles (central to southern Labrador). The NCC also holds a licence for salmon, trout and Arctic char in the tidal waters of that portion of Upper Lake Melville (Ball, 2017 pers comm; Statoil 2017). The Atlantic salmon fishery remains an integral part of the way of life (Martin 2009, in Alderon Iron Ore Corp. 2012). NCC members have been documented as fishing throughout Central and Southeastern Labrador, including around Happy Valley-Goose Bay, Grand Lake and its tributaries, Sebaskachu Bay and Sebaskachu River, Mud Lake, Traverspine River, the mouths of Caroline Brook, McKenzie River and lakes south of the Churchill River, including Minipi Lake and Dominion Lake (Alderon Iron Ore Corp 2012).

Commercial-Communal Fishing

The NCC is also engaged in commercial-communal fishing with licences held by the NCC or NDC Fisheries Limited. The NCC holds seal harvesting licences in Sealing Areas 4 to 33 (all of Atlantic Canada). NDC Fisheries operates enterprises for groundfish in NAFO 2GHJ, 3KL and 4RS; scallop in Scallop Areas 1 and 2 (most of coastal Labrador); shrimp in Shrimp Area 6 (southern Labrador and northern Newfoundland; whelk in NAFO 2J; as well as licences for northern shrimp, snow crab, capelin, herring and toad crab in southern Labrador; and bait in the Area of Home Port (Ball, 2017 pers comm; Statoil 2017).

Bird/Egg Harvesting

Traditional hunting areas in Labrador include the waters and islands of the Backway, Table Bay and St. Peter's Bay, which are used for sea duck hunting and the waters of Point Amour, which are used for sea duck and murre hunting (Intervale Associates Inc. 2012). The NCC has developed annual Spring Bird / Egg Harvest and Conservation Guidelines, which specify opening and closing dates, seasonal harvest of birds and gull eggs per household and any associated restrictions (NCC 2013). Members of NCC hunt a variety of birds, including geese and migratory birds such as black ducks (Alderon Iron Ore Corp 2012).

Marine Mammal Harvesting

Members of NCC harvest marine mammals (NCC 2010), with seals providing income and a source of meat (Alderon Iron Ore Corp 2012). The NCC has a FSC licence for seals, which are harvested on the coast from Fish Cove Point to Cape Charles (Ball, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The availability of community infrastructure within each of these communities is variable. For example, some communities have road access, airstrips, basic municipal services and nursing clinics, while others lack these services and residents must travel to other communities to access them (Martin et al 2012). Health, policing, and education services also vary among the communities, as summarized in Table 7.38.

Table 7.38 Socioeconomic Overview of Southeastern Labrador Communities

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Community governments and other agencies provide services and infrastructure such as health clinics, policing and schools. • A 2012 Health Needs Assessment outlined common health concerns such as high blood pressure, allergies, high cholesterol, arthritis, asthma, and diabetes. • The major employer in the southern Labrador communities is the fishery. Seafood processing facilities are located in Cartwright, Charlottetown, Pinsent's Arm, Mary's Harbour, and L'Anse au Loup. NDC Fisheries Limited holds quotas snow crab and shrimp. • Seasonal and year-round businesses include accommodations, convenience stores and gas bars.	• Limited information is publicly available on the physical and cultural heritage of NCC members.	• Nearly 800 Inuit and Thule archaeological sites have been identified in Northern, Central and Southern Labrador (the latter being the core area where most NCC members reside, and which is the focus of their land claim) and on the top of the Northern Peninsula.
Sources: Nunacor (2017); NLPAO (2017); Labrador Shrimp Company (2014); Martin et al (2012)		

7.4.3.4 Miawpukek First Nation

The Samiajij Miawpukek Reserve is located at the mouth of the Conne River on the south coast of the Island of Newfoundland (Figure 7.82). According to oral history, the Miawpukek community was established in 1870. The Miawpukek First Nation was recognized as a Band in 1984 and the Reserve was officially designated as Samiajij Miawpukek Indian Reserve under the *Indian Act* in 1987 (INAC 2017).

The Registered First Nation population of the Miawpukek First Nation is more than 3,000 individuals. Nearly 28 percent were living on the Reserve in October 2017 (INAC 2017). The Reserve population was 956 in 2016, an increase of 3.9 percent since 2011. The population is younger than the Newfoundland and Labrador population overall (SC 2017).

Self-government framework agreement negotiations began between the Miawpukek First Nation and the federal and provincial governments in 2004 and an agreement was signed in 2005. The community has developed a formalized mechanism to allow input from members living on and off reserve as well as non-member residents of the reserve. In 2013, Miawpukek First Nation signed a Self-Government AIP with the governments of Canada and Newfoundland and Labrador. The AIP is not a treaty or a land claims agreement within the meaning of Sections 25 and 35 of the *Constitution Act, 1982*. The Agreement was an important step towards self-government and planning and management of economic opportunities and delivery of services to address community needs in culture and language, education, health, child and family services, land management, resource management, licensing, regulation and operation of business, and administration of justice. Progress is being made toward a final agreement (Miawpukek First Nation 2017; INAC 2017; GNL 2013).

Current Use of Lands and Resources for Traditional Purposes

The Miawpukek First Nation holds FSC and commercial-communal fishing licences. The following sections discuss these activities based on available information.

FSC Fishing

Miawpukek First Nation has a FSC licence in the coastal waters of 3Ps, which is southern Newfoundland. This licence includes scallop, lobster, mackerel, herring, rainbow trout, brook trout, Atlantic cod, eel, smelt, capelin, harp seal grey seal, snow crab and redfish (Ball, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Miawpukek First Nation is engaged in commercial-communal fishing through its own licences and those held by MAMKA. Miawpukek First Nation holds commercial-communal licences for groundfish in NAFO 2GHJ, 3KL, 3Pn and 3Ps, groundfish (mobile gear) in 2GHJ, 3KL, 3Pn, 3Ps, 4R, bluefin tuna in NAFO 3LNOP-Atlantic and seal in Areas 4 to 33 (all of Atlantic Canada). The First Nation also holds licences for sea cucumber and whelk in NAFO 3Ps (southern Newfoundland); capelin in Areas 1-11 and 10 (northern Labrador to southern Newfoundland); herring in Area 11 (southern Newfoundland); mackerel in Areas 10, 11 and 1-11 (northern Labrador to southern Newfoundland); snow crab in Areas 10 and 11 (southern Newfoundland); and squid in Squid Area 10 (Placentia Bay). Miawpukek also holds licences

for other tuna species, swordfish, scallop and bait (Ball, 2017 pers comm; Statoil 2017). In addition, Miawpukek First Nation also holds tuna and swordfish licences for the Scotia-Fundy region (O'Neil 2017, pers. comm.).

Other Socioeconomic Components

This section provides information on other socioeconomic aspects of Miawpukek First Nation (Table 7.39), based on the nature and extent of existing and available information.

Table 7.39 Socioeconomic Overview of the Miawpukek First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Miawpukek First Nation has self-initiated enterprises such as aquaculture, Christmas tree farming, outfitting, fisheries, retail, a nature park with tourist amenities. • Conne River Health and Social Services provides access to community health services (e.g., medical clinic, wellness centre, youth centre and nutrition centre), ambulance services, on-call nurses as well as schools.	• As discussed, Mi'kmaq traditional spiritual beliefs are holistic - all living things, plants, animals and humans have a spirit and all living things are interdependent. • Cultural and traditional values are important to Miawpukek First Nation and all policy-making is centered around them.	• There are 21 Mi'kmaq archaeological sites identified in interior and coastal areas of Newfoundland, between the Port au Port Peninsula and Clarenville.
Sources: Miawpukek First Nation (2017); INAC (2012a); Explore Newfoundland and Labrador (2010); CRHSS (2008)		

7.4.3.5 Qalipu Mi'kmaq First Nation

The Qalipu First Nation Band was established in 2011. In October 2017, the Band had a registered Population of more than 24,000 members. Although Qalipu has no reserve land, its members are known to live in 66 communities throughout Newfoundland and in other areas. The Band's main administrative office is in Corner Brook and satellite offices are located in Glenwood, Grand Falls-Windsor and St. George's (Qalipu First Nation 2016) (Figure 7.82).

In 1972, the Federation of Newfoundland Indians (FNI) was formed with the primary goal of obtaining recognition for Mi'kmaq people in Newfoundland under the *Indian Act* (Qalipu First Nation 2016). In 2008, the Government of Canada signed an agreement with the FNI to establish a landless Band for the Mi'kmaq of Newfoundland (INAC 2017). With no associated land base, the Agreement is not a treaty within the meaning of section 35 of the *Constitution Act, 1982*. The Agreement initiated the enrolment process for the Mi'kmaq of Newfoundland (Qalipu First Nation 2016).

The *Qalipu Mi'kmaq First Nation Act* received Royal Assent in 2014. A total of 101,000 individuals applied for founding membership in the Band. In 2017, INAC accepted a total of 18,000 members. Others may be registered as children of founding members and the founding member list will be finalized in 2018 (INAC 2017).

Current Use of Lands and Resources for Traditional Purposes

The Mi'kmaq continue to hunt, trap and fish for subsistence purposes, using extensive areas of land, sea and inland waters. Important sources of traditional food include moose, caribou, partridge, snowshoe hare, salmon, trout, eel, shellfish and wild berries, with migratory birds, seals and groundfish of lesser importance but still harvested. The harvesting of groundfish, pelagic fish, shellfish, and seals are also of importance to the Mi'kmaq on the west coast of Newfoundland (Emera NL 2013). The Qalipu are undertaking studies to understand and monitor specific species, including the Arctic hare, woodland caribou, elver and glass eel, commercial eel, Atlantic salmon, eelgrass, golden star tunicate and the European green crab (Qalipu First Nation 2016).

Commercial-Communal Fishing

The Qalipu Mi'kmaq First Nation and Mi'kmaq Commercial Fisheries hold commercial-communal fishing licences. These include groundfish licences in NAFO 2J, 3Pn, 4RST, 2GHJ and 3KL. The Qalipu has licences to harvest lobster in Lobster Areas 4B, 13A, 13B (eastern and western Newfoundland) and snow crab in Snow Crab Areas 4, 12, 12C, 12E and 12F (eastern and western Newfoundland). Various mackerel fishing licences are held in Mackerel Areas 1-11, 3-8, 4, 13 and 13B (coastal Labrador, and eastern and western Newfoundland). The group has licences for herring for Herring Area 13 (western Newfoundland); squid in Squid Areas 4 and 13 (eastern to western Newfoundland); scallop in Scallop Area 13 (western Newfoundland); capelin in Capelin Areas 1-11 and 13 (northern Labrador to western Newfoundland); whelk in Whelk Area 13 (western Newfoundland); shrimp in Shrimp Area 6 (northern Newfoundland) and licences to harvest bait in the Area of Home Port or Lobster Area. Qalipu Mi'kmaq First Nation also has licences for eel and smelt (Ball, 2017 pers comm; Statoil 2017).

The Qalipu Mi'kmaq First Nation Band (Qalipu) and the Miawpukek First Nation (MFN) have developed a joint fisheries initiative, Mi'kmaq Alsumk Mowimsikik Koqoey Association (MAMKA) under the AAROM program (MAMKA 2014). MAMKA holds commercial-communal licences for a variety of species including groundfish in NAFO 2GHJ, 3KL, 3Pn, 3Ps in offshore Newfoundland and 4RST in western Newfoundland; whelk in NAFO 3Ps; snow crab in Snow Crab Areas 10, 11, 12 C and 12E (southern and western Newfoundland); herring in Herring Areas 10 and 13 (Placentia Bay and western Newfoundland); capelin in Capelin Area 10 (Placentia Bay); lobster in Lobster Areas 13A and 13B (western Newfoundland); and bait in the Area of Home Port or Lobster Area. MAMKA also hold a commercial-communal scallop licence (Ball, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

As Band members live in more than 60 communities throughout Newfoundland and these communities are not exclusively occupied by Qalipu Mi'kmaq, consolidated information on infrastructure and services, economic conditions, and community health is not available (Table 7.40). Members access services and programs provided by municipal and provincial agencies, private businesses and service agencies in communities and regions where they reside.

Table 7.40 Socioeconomic Overview of the Qalipu Mi'kmaq First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• The Qalipu Business Trust Committee manages economic development. Businesses and business partnerships have been established in construction, construction support, safety, industrial supply and transportation.	• Mi'kmaq traditional spiritual beliefs are holistic - all living things, plants, animals and humans have a spirit and all living things are interdependent. • As a recently formed band, Qalipu is working to create teachings and new ceremonial ways.	• Currently, 21 known Mi'kmaq archaeological sites are located in interior and coastal areas of Newfoundland, between the Port au Port Peninsula and Clarenville.
Sources: NLPAO (2017); Qalipu First Nation (2016); Qalipu Mi'kmaq First Nation (2015); NLPAO (2013)		

7.4.4 Mi'kmaq First Nations of Nova Scotia

The Mi'kmaq make up the majority of the Indigenous population in Nova Scotia and Prince Edward Island and a large portion of the Indigenous population of New Brunswick and the Gaspé Peninsula of Québec as well as the northern portion of the State of Maine. The common history of the Mi'kmaq people of Eastern Canada is summarized in this section. Information specific to Indigenous groups within any province is presented in the appropriate sections.

The provinces of Nova Scotia, New Brunswick, Prince Edward Island and Québec are founded on land occupied by the ancestors of the Mi'kmaq. The earliest evidence of Indigenous peoples in the Maritimes shows that the Mi'kmaq have existed on the land for more than 11,000 years (NSOAA 2017).

The Mi'kmaq are known to have been part of a confederacy of nations belonging to the broader Wabanaki Confederacy that included other eastern Indigenous peoples such as the Passamaquoddy, Penobscot, Abenaki and Wolastoqiyik (also called Maliseet). These groups lived a traditional lifestyle as fishers, hunters and gatherers throughout their territory and considered the seasonal cycles of the local vegetation, animals and fish in their harvesting activities (MGS 2016). The Mi'kmaq believe that they have a spiritual connection to land, plants, animals and water and the interconnectivity of these resources (GNB 2000).

The Mi'kmaq generally lived in semi-permanent and permanent settlements at resource-rich locations with summer villages typically located by a navigable body of water (Mi'kma'ki All Points Services, 2013). In the summer, areas around the coastal camps provided fish, shellfish, fowl and eggs. During the colder months, the Mi'kmaq moved inland from their summer camps in pursuit of game. Also, when resources such as fish, game and plants became scarce near the proximity of an encampment, the Mi'kmaq moved to a new location (MGS 2016).

Early European contact with the Mi'kmaq occurred in the 16th and 17th centuries and at that time, the traditional Mi'kmaq territory (known as Mi'kma'ki) stretched from the southern portions of the Gaspé Peninsula eastward to most of modern-day New Brunswick, and all of Nova Scotia and Prince Edward

Island (NSOAA 2015). Mi'kma'ki was divided into various political districts: Cape Breton Island; Canso-Sheet Harbour, Sheet Harbour-LaHave, Southern Nova Scotia, Prince Edward Island, Shediac to Canso Strait, Chaleur Bay to Gaspé and Chaleur Bay to Shediac (MGS 2016).

Following European contact, the Mi'kmaq of the Maritime Provinces and the Gaspé region of Québec signed various treaties with the French and British. In 1610, the Mi'kmaq people and the French Crown created the Concordat Wampum Belt whereby the Mi'kmaq agreed to protect priests and French Catholic settlers and confirmed their right to adopt their choice of religious practice (Henderson 1997). The Peace and Friendship Treaties signed with the British Crown between 1725 and 1779, were intended to encourage military alliances and cooperation, and did not require Indigenous communities to surrender any rights to lands and resources. After Confederation, these treaties became the responsibility of Canada and Indigenous peoples have continued to assert their treaty rights and Aboriginal rights to land, resources and self-government. Based on the results of various SCC decisions, existing Aboriginal and treaty rights are recognized as constitutionally protected under Section 35 of the *Constitution Act, 1982*. Canada is currently negotiating with Indigenous Groups to uphold pre-1975 treaty rights in Nova Scotia, New Brunswick, Prince Edward Island and the Gaspé region of Québec (INAC 2017).

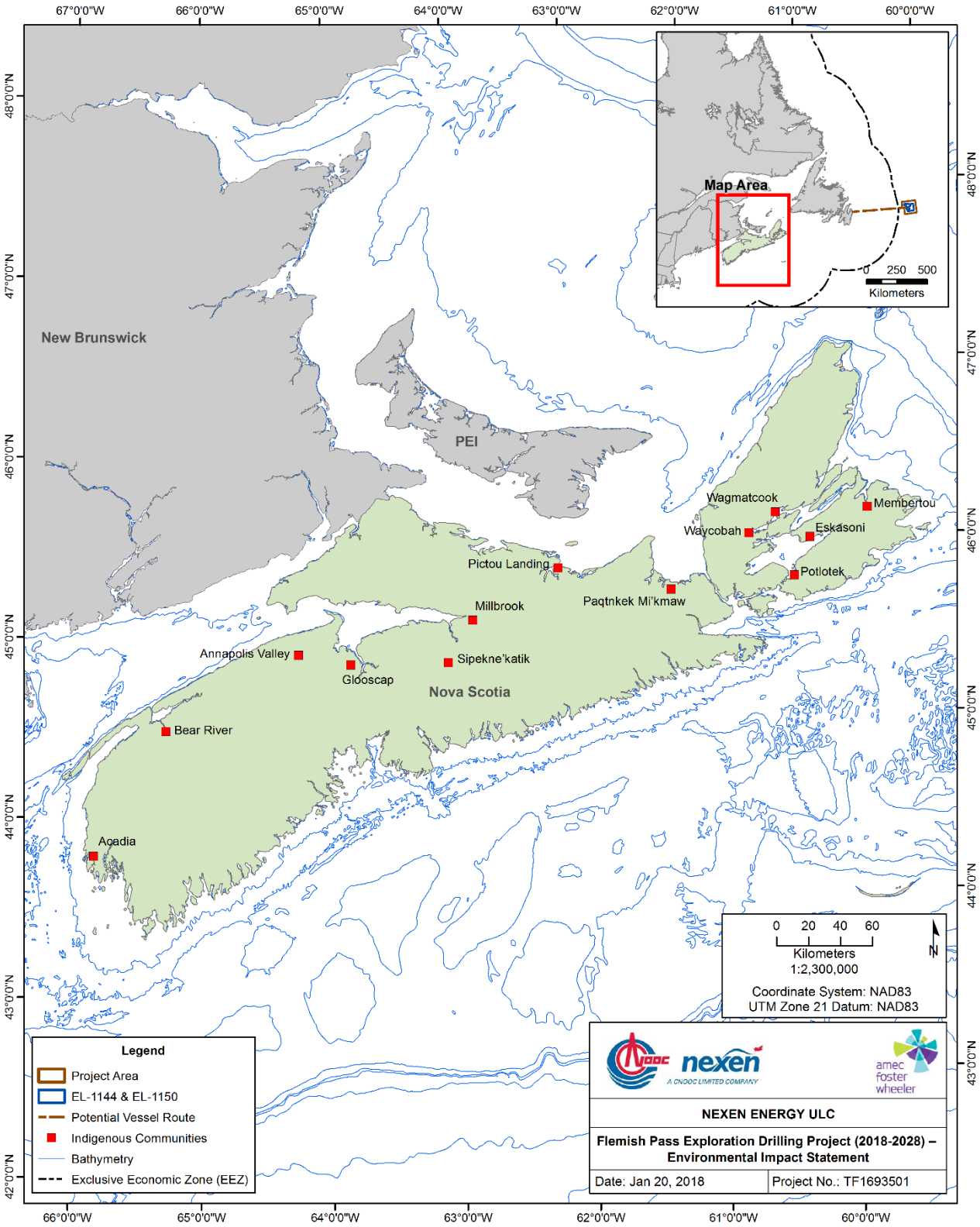
As affirmed by various SCC decisions (including the *Sparrow* Decision in 1990 and *Marshall* Decision in 1999), the Peace and Friendship Treaties guarantee Aboriginal rights to hunt and fish throughout the region and to maintain a moderate livelihood. In 2002 the Mi'kmaq, Nova Scotia and federal governments signed an Umbrella Agreement to establish a negotiation process to resolve outstanding issues. A Framework Agreement was signed in 2007 between the three parties to establish a negotiation process towards a resolution of issues respecting Mi'kmaq Aboriginal and treaty rights and self-government (INAC 2017; NS OAA 2017).

In 2010, the Mi'kmaq First Nations signed an agreement with the Governments of Canada and Nova Scotia under the 2002 Umbrella Agreement. The Mi'kmaq-Nova Scotia-Canada Consultation Terms of Reference established a consultation process for government decision-making that have the potential to adversely impact asserted Mi'kmaq Aboriginal and treaty rights. The Mi'kmaq have also signed agreements with the provincial and federal governments on national parks (2012) and education (1997) (INAC 2017).

Nova Scotia has 13 Mi'kmaq First Nations, with elected Chiefs and Councils. These are located throughout the province from Cape Breton to the Yarmouth area (Figure 7.86). Six of the Nova Scotia Mi'kmaq First Nations are members of the Union of Nova Scotia Indians (UNSI) and seven are members of the Confederacy of Mainland Mi'kmaq (CMM). All 13 Mi'kmaq communities located in Nova Scotia are discussed in further detail below.

Eleven of the Nova Scotia Mi'kmaq First Nations are currently represented by the Assembly of Nova Scotia Mi'kmaq Chiefs (ANSMC) in treaty negotiations and consultation on decisions/actions that may affect Mi'kmaq Aboriginal or treaty rights. The administrative office of the ANSMC, the Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO), coordinates these activities. Sipekne'katik and Millbrook First Nations withdrew from the ANSMC (in 2013 and 2016 respectively) and currently represent themselves in consultation. Both First Nations still assert the same rights as the other Mi'kmaq communities (INAC 2017).

Figure 7.86 Indigenous Communities in Nova Scotia



The Nova Scotia Mi'kmaq First Nations have established Aboriginal and Treaty rights, and assert title to all of Nova Scotia and parts of the offshore. The Mi'kmaq used the land and waters around Nova Scotia for travel corridors, hunting and harvesting and fishing for traditional and commercial purposes. The discussion of current use of lands and resources for traditional purposes by Nova Scotia First Nations is mainly focused on activities occurring in the marine environment and (where possible) any species of cultural importance and interests that may migrate through the marine environment in or near the Project Area. The current use of lands and resources sections include a discussion of FSC harvesting and commercial-communal fishing for each community.

7.4.4.1 Acadia First Nation

The history of the Mi'kmaq is outlined above. Acadia First Nation's traditional activities were centred in Queen's County, Nova Scotia. Acadia First Nation, which obtained official Band status in 1976, has five reserves located in southern Nova Scotia between Halifax and Yarmouth (INAC 2017). Acadia First Nation and is a member of the UNSI and represented by the ANSMC in negotiations (UNSI 2017; KMKNO Undated).

The October 2017 registered Indian population of Acadia First Nation was 1,537 people. Approximately 15 percent of these (232 individuals) live on the Reserves (INAC 2017). The median age (i.e., 33.8 to 38.2 years of age) of the population is approximately 10 percentage points below that of Nova Scotia in general, which was 45.5 years in 2016 (SC 2017). No data are available for Medway River Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes. The discussion that follows is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

The Acadia First Nation holds FSC fishing licences for a variety of species (i.e., blue shark, blueback herring, brook trout, gaspereau, herring, mussel, periwinkle, seal, smallmouth bass, soft-shell clams, squid, striped bass, tomcod, quahaug, rainbow trout, razor clams) in inland and tidal waters of Nova Scotia. The First Nation also holds an FSC license to fish for several species including groundfish (i.e., cod, catfish, haddock, halibut and pollock) in NAFO 4X in southwestern Nova Scotia, and lobster and crab (other than snow crab) in Lobster Areas 33, 34 and 35, which include southwest Nova Scotia and the Bay of Fundy. Scallop licences are held for Scallop Areas 28A and 29, and in negotiation for Areas 29A, 29B, 29C, 29D and 29E, which encompass coastal areas of Nova Scotia from Cape Breton to Yarmouth. The First Nation also has access to Atlantic salmon in Inverness County, Cape Breton. There are no location restrictions on gaspereau, eel, mackerel, shad, smelt, green crab, Jonah crab or bait (mackerel and herring) fishing (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

The Acadia First Nation holds commercial-communal licences for gaspereau, clams, crab (i.e., green, Jonah and snow), eel, groundfish (unspecified), herring, mackerel, lobster, marine worm, ocean quahaug, sea scallop and tuna. Where location are identified, these species may be harvested in inland,

tidal and coastal areas around the province but mainly focussed on southwest Nova Scotia and the Bay of Fundy (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The Acadia First Nation is a small community and limited health and socioeconomic information was publicly available. It is also likely given the proximity of the Reserves to larger urban centres, that these communities are closely linked to regional service centres and economic generators. The following table summarizes the available information.

Table 7.41 Socioeconomic Overview of the Acadia First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Acadia First Nation and other agencies provide services and infrastructure such as a youth centre, day care, after school programs, parenting programs, community health clinics including dental and foot care. Offices in Halifax and Milton serve the off-reserve population. • Construction projects such as administrative buildings, gaming facilities provide employment for the community members • Kespuwick Resources was established in 2001 for areas of Yarmouth and Lunenburg Counties with the main onshore facilities in Yarmouth. Acadia First Nation has 50 harvesting licences across 15 species, focused on lobster within Lobster Fishing Area (LFA) 33 and 34 as well as Atlantic blue fin, tuna, snow crab, scallops, gaspereau and swordfish.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • Acadia First Nation cultural practices and resources are focused on the lands and waters of NS.	• Artifacts have been found along the Mersey River. • An interpretive centre is being developed to display archaeological and cultural history of the community. • Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

7.4.4.2 Annapolis Valley First Nation

Annapolis Valley First Nation is located in central Nova Scotia and has two reserves: Cambridge and St. Croix. Annapolis Valley First Nation is a member of the CMM and represented by ANSMC in negotiations (INAC 2017).

The current Registered population of Annapolis Valley First Nation is 291 with 117 (40 percent) living on-Reserve. A larger proportion of the population lives off Reserve (INAC 2017). The population of the Reserve is younger than that of Nova Scotia by approximately 13 years (SC 2017). No population data were available for St. Croix Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Annapolis Valley First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Annapolis Valley First Nation holds FSC fishing licenses for various species such as brown trout, rainbow trout, speckled trout, clams, herring, mackerel and mussels within tidal and inland waters of Nova Scotia. Licences are held for eel, flounder, halibut and pollock in the Bay of Fundy. Gaspereau and shad may be fished in the river system along the upper Bay of Fundy and the south coast of Nova Scotia (mainly Kings and Lunenburg counties). There are no location restrictions for smelt. Annapolis Valley First Nation also holds an FSC licence to fish for groundfish, lobster and scallops in NAFO divisions in and around Nova Scotia. The First Nation also has FSC access to Atlantic salmon in Inverness County, Cape Breton (Newbould 2017, pers comm; Statoil 2017).

Commercial-Communal Fishing

Annapolis Valley First Nation holds commercial-communal licences for gaspereau, crab, groundfish (unspecified), herring, lobster, marine worm, sea scallop and sea urchin in fishing areas around Nova Scotia including Annapolis, Digby and Kings Counties, and the Bay of Fundy. There are no location restrictions on green crab and bait (herring and mackerel) (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Annapolis Valley First Nation Reserve communities are small and located near larger urban centres. The following summary is based on limited publicly available information on socioeconomic conditions in the community (Table 7.42).

Table 7.42 Socioeconomic Overview of the Annapolis Valley First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Annapolis Valley First Nation and other agencies provide services and infrastructure such as housing. • Annapolis Valley First Nation owned businesses include a gaming facility, smoke shop and gas bar. • Annapolis Valley holds commercial-communal licences and a lobster fishing boat.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • Mi'kmaq lifestyles were strongly connected to their homelands. Annapolis Valley First Nation cultural practices and resources are focused on the lands and • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Annapolis Royal and surrounding areas have a long history of Mi'kmaq presence and archeologists have identified several settlement patterns and associated historic resources. • Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Annapolis Royal (2017), Annapolis Valley First Nation (Undated)		

7.4.4.3 Bear River First Nation

The Bear River Mi'kmaq have lived and travelled throughout Digby and Annapolis counties for thousands of years. The traditional economy was based on hunting, fishing and gathering and guiding non-native hunting and fishing. The community was also known for its artwork including embroidering porcupine quills on birchbark, leatherwork and basketry. During the fall and winter, families would disperse to hunt big game (moose, deer, caribou and bear) and smaller animals (beaver, some bird species and rabbit). In spring families settled along the coast and in the summer, they harvested shellfish (clams, mussels and scallops) and several fish species (cod, salmon, trout, eel, herring and bass). The Mi'kmaq of Bear River also harvested lobster, seal, walrus and porpoises as well as berries and plants (Mainland Mi'kmaq Development Inc. 2016).

Bear River First Nation is located in the Annapolis Valley between the communities of Annapolis Royal and Digby (KMKNO Undated). Bear River First Nation, established in 1801, is presently comprised of three reserves. Bear River First Nation is a member of the CCM and represented by ANSMC in negotiations (INAC 2017).

The current Registered population of the Bear River First Nation is 343. About 32 percent lives on the Reserve and the remainder lives in other areas (INAC 2017). The majority of the population live on the Bear River 6 Reserve, which is also known as L'sitkuk Mainland (Mi'kmaq Development Inc. 2016). The population of the Bear River First Nation is younger and growing at a much higher rate than that of the Province (SC 2017). Most population data for Bear River 6A and 6B were supressed in the 2016 census.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Bear River First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Bear River First Nation holds FSC fishing licenses to harvest various species (i.e., bar clam, gaspereau, herring, landlocked salmon, mackerel, mussel, quahaug, razor clam, smallmouth bass, soft-shelled clam, striped bass and trout within the inland and tidal waters of Nova Scotia. Seal may be harvested in tidal waters adjacent to Nova Scotia. Bear River First Nation also holds licences to harvest groundfish, lobster, crab (other than snow crab) and scallop in NAFO divisions around Nova Scotia. There are no restrictions on the fishing of eel, shad or smelt. Bear River First Nation has FSC access to Atlantic salmon in Inverness County, Cape Breton (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Bear River First Nation holds commercial-communal licences for clams (unspecified) and lobster for coastal areas of Nova Scotia and the Gulf of St. Lawrence. There are no location restrictions for fishing tuna (unspecified species) (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

These Reserve communities are relatively small and limited public information is available on their socioeconomic conditions (Table 7.43). Bear River First Nation is located near larger regional service centres in southern Nova Scotia. Thus, the community is likely to rely on nearby centres for commercial and government services and for employment.

Table 7.43 Socioeconomic Overview of the Bear River First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Bear River First Nation and other agencies provide infrastructure and services including a health clinic, policing office and space for educational activities. • Reserve businesses include a gas bar and the heritage and cultural centre.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • Traditional values include respecting elders, sharing and striving to live happy and peaceful lives. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: KMKNO (Undated); Mainland Mi'kmaq Development Inc. (2016)		

7.4.4.4 Eskasoni First Nation

The Eskasoni First Nation is located along the shore of Bras d'Or Lake and consists of three Reserves. Eskasoni First Nation was charted in 1832 and became an official reserve in 1834. Between 1845 to 1851 the Mi'kmaq began to transition into permanent settlements, finding employment in the community and travelling to Sydney to work and sell handicrafts. The population of Eskasoni grew in the 1940s when the Department of Indian Affairs began a centralization process that moved Indigenous people into fewer communities. In the 1950s, Eskasoni began taking control of their own affairs and a Band Council was first elected in 1958 (Eskasoni First Nation Undated; INAC 2017).

The Eskasoni First Nation has the largest population of any Indigenous community in Atlantic Canada (KMKNO Undated). The October 2017 population was nearly 4,500 with approximately 85 percent living on the Reserves. The combined population of the communities that make up Eskasoni First Nation is approximately 98 percent Registered Indians (INAC 2017). The population is young, nearly 22 years younger than the Nova Scotia median age (SC 2017). No census data are available for two of the Reserves (i.e., Eskasoni 3A or Malagawatch 4).

Current Use of Lands and Resources for Traditional Purposes

Eskasoni First Nation is involved in both FSC and commercial-communal fisheries. From 2012-2014, nearly 10 percent of Eskasoni's revenue came from commercial fisheries. Crane Cove Seafood, a commercial fishery company owned and operated by Eskasoni First Nation, is the largest employer in Eskasoni and employs 150 fishermen 12 full time staff. Eskasoni is also home to the Unama'ki Institute of Natural Resources (UINR), which was formed to address the concerns of the five Mi'kmaq communities of the Unama'ki district, with regard to natural resource sustainability (Gillies 2014).

FSC Fishing

The Eskasoni First Nation holds FSC fishing licenses to harvest clam, cod, founder, haddock, mussel, quahaug, scallop, shad, smelt and trout in inland and tidal waters of Nova Scotia, Cape Breton and in the case of eel, also in Antigonish Harbour. The First Nation also holds an FSC licenses to fish lobster around Cape Breton. Salmon licences are focussed on Inverness and Victoria Counties of Cape Breton including the Margaree River and North River (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

The Eskasoni First Nation holds commercial-communal fishing licenses to harvest snow crab, herring, lobster and northern shrimp, within inland and tidal waters of Nova Scotia mainly from Cape Breton, including Bras d'Or Lake, to southwest Nova Scotia. Groundfish (unspecified) licences cover NAFO areas from Cape Breton to the Gulf of Maine. There are no location restrictions on gaspereau, eel, mackerel and bait (herring and mackerel) (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Eskasoni is a larger First Nation community and thus provides a range of services and infrastructure on the Reserves. Eskasoni is also located 50 km from Sydney where members likely access services. Available information is summarized in Table 7.44.

Table 7.44 Socioeconomic Overview of the Eskasoni First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Eskasoni First Nation and other agencies provide infrastructure and services such as housing, a school, rink, fire department. Several businesses, including a supermarket, are located on Reserve. • The First Nation operates a fishing operation, which has 13 vessels that engage in fisheries from Ingonish to Yarmouth. Eskasoni First Nation also has a seafood processing plant.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area
Sources: SC (2017); KMKNO (Undated), Eskasoni (Undated); MGS 2012		

7.4.4.5 Glooscap First Nation

Glooscap First Nation is located near Hantsport on the Avon River and has one reserve. Glooscap, which was named Horton until 2001, was formerly a reserve of the Annapolis Valley First Nation. Upon separation in 1984, Glooscap First Nation became its own Band (KMKNO Undated). Glooscap First Nation is a member of the CMM and represented by the ANSMC in negotiations (INAC 2017).

The Registered Indian population of Glooscap First Nation was 378 in October 2017. Only 95 individuals, or 25 percent, live on the Reserve (INAC 2017). The population of Glooscap First Nation is experiencing growth. The population is younger than that of the Nova Scotia population in general (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Glooscap First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Glooscap First Nation holds FSC fishing licenses for a variety of species (i.e., brown bullhead, chain pickerel, gaspereau, smallmouth bass, trout, white perch, white sucker fish, yellow perch) within the inland and tidal waters of Nova Scotia. Harvesting is permitted for various species (i.e., cod, flounder, haddock, halibut, pollock) in the Bay of Fundy. Mackerel and soft-shelled clams are fished in the Bay of Fundy and coastal waters adjacent to Lunenburg, Queens, Shelburne, Kings, Annapolis and Hants Counties. Lake fish are harvested in inland waters and striped bass in inland and tidal waters that border the Bay of Fundy and the Atlantic Ocean. Glooscap First Nation also holds an FSC license to fish lobster and scallop in NAFO divisions around Nova Scotia. There are no location restrictions for fishing eel, shad and smelt. Glooscap First Nation has FSC access to Atlantic salmon in Inverness County, Cape Breton (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Glooscap First Nation holds commercial-communal licences for a variety of species (i.e., unspecified groundfish, lobster, mackerel and marine worm) in fishing areas throughout Nova Scotia mainly in the southwest, Gulf of Maine and Bay of Fundy. There are no location restrictions for fishing gaspereau, mackerel, tuna and bait (herring and mackerel). Glooscap First Nation holds a swordfish licence for areas including NAFO 3L, 3M, 3N, 3O, 3Ps in offshore Newfoundland along with NAFO divisions around Nova Scotia and the Gulf of Maine (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Limited information is available on socioeconomic conditions of the Glooscap First Nation. The following sections describe the community based on available information. See Table 7.45.

Table 7.45 Socioeconomic Overview of the Glooscap First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Glooscap First Nation and other agencies provide infrastructure and services including educational support, a health and healing centre. • Glooscap First Nation's economic endeavours include on-reserve businesses such as a variety store/gas bar, gaming facility and retail development. • Glooscap First Nation is engaged in commercial fisheries.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Glooscap First Nation (2017); KMKNO (Undated)		

7.4.4.6 Membertou First Nation

Membertou First Nation, which was officially established in 1926, is located in Cape Breton and consists of four reserves. Membertou was formerly located along the banks of Sydney Harbour and home to dozens of Mi'kmaq families. As Membertou was located in an urban area, few families relied solely on hunting, fishing and gathering to earn their living and many worked in construction and other service sectors in neighbouring communities. The community was relocated in 1926 to its present location. Membertou First Nation is a member of the UNSI and represented by ANSMC in negotiations (Membertou First Nation Undated, INAC 2017).

The October 2017 Registered Indian population of Membertou First Nation was 1,526 of which about one third lives on the Membertou Reserves. Approximately 40 members live on other Reserves (INAC 2017). The population of the Membertou Reserve is growing in comparison to the overall Nova Scotia population. Like most of the other Nova Scotia First Nations, the median age is below that of the Nova Scotia population (SC 2017). No population data were available for Sydney 28A, Caribou Marsh 29 or Malagawatch 4.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Membertou First Nation. This discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Membertou First Nation holds FSC fishing licenses to harvest various species (i.e., clams, cod, crab, eel, flounder, haddock, halibut, mussel, oyster, pollock, quahaug and smelt) within the tidal waters of Cape Breton, the Atlantic Ocean and Bras d'Or Lake, and in the case of striped bass in Bras d'Or Lake and Mira River. Mackerel may be harvested around Cape Breton and northern Nova Scotia. Salmon may be harvested in Inverness and Victoria Counties, Cape Breton including the Margaree River and Estuary. Lobster fishing is permitted around Cape Breton, and scallop fishing in nearshore areas from Cape Breton to southwest Nova Scotia (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Membertou First Nation holds commercial-communal licenses for crab (rock and snow), eel, groundfish (unspecified), herring, lobster, sea scallop, sea urchin, northern shrimp and unspecified tuna species. These licences are for coastal and marine areas of Nova Scotia mostly around Cape Breton but also include the coast of southwest Nova Scotia and the Gulf of Maine for some species. There are no location restrictions on gaspereau, eel, mackerel and bait (herring and mackerel) Membertou First Nation also holds a commercial-communal licence for bluefin tuna in inshore areas of the Gulf Region (O'Neil 2017 pers comm.; Belanger 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Membertou First Nation has a small population and limited information was found to be publicly available on its socioeconomic characteristics (Table 7.46).

Table 7.46 Socioeconomic Overview of the Membertou First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Membertou First Nation and other agencies provide services and infrastructure such as housing, health care, recreation, social programs, a school, a church, policing, wellness programs and community supports. • Membertou First Nation has developed various initiatives including a trade and convention centre, business park, recreation complex as well as tourist attractions, gaming facility, accommodations, food services, insurance, geomatics, information technology, gas station, convenience store, supermarket and fisheries. • Membertou First Nation is also engaged in initiatives with partners such as Cape Breton University and other Indigenous groups. • Membertou First Nation owns and operates a seafood company with six vessels that harvest groundfish, shellfish and large pelagic species including tuna and swordfish.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Membertou First Nation (Undated); MFNCD (Undated)		

7.4.4.7 Paqtnkek Mi'kmaw First Nation

The Paqtnkek (also spelled Paq'tnkek) Mi'kmaw First Nation was established in 1820 in Antigonish County, and is made up of three reserves. Paqtnkek-Niktuek 23 and Welnek 38 Reserves are located near Antigonish and Franklin Manor 22 Reserve is near Amherst. Paqtnkek Mi'kmaw Nation is a member of the CMM and represented by the ANSMC in negotiations (INAC 2017).

The total First Nation population was 585 in October 2017. Approximately 70 percent live on the Paqtnkek Reserve and 28 live on other reserves (INAC 2017). Census data are not available for Paqtnkek Mi'kmaw Nation Reserves but census data are partially included in Pomquet and Afton 23 census sub-division. Pomquet and Afton's population declined by 5.4 percent in the 2016 census and the population is younger than the Nova Scotia population in general (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

The Paqtnkek Mi'kmaw Nation are known to traditionally harvest marine fish and shellfish resources along the coast, including the southern Chedabucto coastline where the waters are generally ice-free during the winter months. Harvested marine species include mackerel, herring, cod, haddock, sea urchins, mussels, oysters, clams and snow crab in the deeper waters. Freshwater species includes salmon, trout and eel (Mi'kma'ki All Points Service 2013).

The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Paqtnkek Mi'kmaw Nation harvests marine fish and shellfish resources along the coast, including southern areas of Chedabucto Bay where the waters generally do not freeze during the winter months. Marine resources harvested in this area include mackerel, herring, cod, haddock, sea urchin, mussel, oyster and clam as well as snow crab in deeper waters. Freshwater species include salmon, trout, and eel (Mi'kma'ki All Points Service 2013). Paqtnkek First Nation holds an FSC licence for sea urchin in Guysborough County and is engaged in fishing salmon, striped bass and eel for FSC purposes. Paqtnkek First Nation has FSC access to Atlantic salmon in Pictou and Antigonish Counties, eel in Antigonish County and striped bass in inland and tidal waters of Nova Scotia (O'Neil 2017, pers comm; Belanger 2017, pers comm; Statoiil 2017)

Commercial-Communal Fishing

Paqtnkek Mi'kmaw Nation holds commercial-communal licences for various species (i.e., rock crab, herring, mackerel, lobster, sea scallop, snow crab, squid and swordfish) in inshore and coastal areas of Nova Scotia. There are no location restrictions for harvesting eel, American oyster, smelt and marine plants. Paqtnkek Mi'kmaw Nation also holds inshore groundfish licences for 3Pn in offshore Newfoundland along with NAFO divisions around Nova Scotia (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes the socioeconomic characteristics of the of the Paqtnkek Mi'kmaw Nation, based on publicly available information (Table 7.47).

Table 7.47 Socioeconomic Overview of the Paqtnkek Mi'kmaw Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Paqtnkek Mi'kmaw Nation provides infrastructure and services such as housing, water and sewer, snow removal, roadway construction and maintenance, emergency management, policing. The reserve has a pre-school, health centre and multi-purpose facility. • Paqtnkek Mi'kmaw Nation is engaged in economic development including an entertainment centre, gas bar, smoke shop, and a new development along Highway 104. • Paqtnkek Fisheries harvest lobster, snow crab and herring from 5 communally-held vessels. Lobster licences are located at Bayfield Wharf and snow crab licenses are located at the Port of Cheticamp, 160 km north of the community.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Paq'tnkek Mi'kmaw Nation (undated)		

7.4.4.8 Pictou Landing First Nation

Historically, Pictou Landing Mi'kmaq lived on a seasonal basis in and around a small tidal estuary connected to the Northumberland Strait. The location provided a variety of fish and shellfish as well as areas for hunting and trapping near the shores (Pictou Landing First Nation undated).

Pictou Landing First Nation is presently located on the south shore of the Northumberland Strait in Pictou County, NS. Pictou Landing First Nation includes four reserves in the New Glasgow area (i.e., Fisher's Grant 24, Fisher's Grant 24G, Boat Harbour West 37, Merigomish Harbour 31) and a portion

of another Reserve near Amherst, which is also affiliated with Paq'tnkek Mi'kmaw Nation. Pictou Landing First Nation is a member of the CMM and represented by the ANSMC in negotiations (INAC 2017).

The Registered First Nation population of the Pictou Landing First Nation is currently 663. Approximately 73 percent lives on Pictou Landing First Nation Reserve lands (INAC 2017). In 2016, Fisher's Grant 24 Reserve had a population of 485 and a small population lived on Merigomish Harbour Reserve (INAC 2017). Like many of the Nova Scotia First Nations, the population is young and growing. No population data were available for Boat Harbour West 37 and Fisher's Grant 24G Reserves (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Pictou Landing First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Pictou Landing First Nation holds FSC licences for lobster, salmon, striped bass and trout. These licences cover inland and tidal areas of Nova Scotia, most particularly in Pictou and Inverness Counties (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Pictou Landing First Nation holds commercial-communal licences for a variety of species (i.e., rock crab, spider/toad crab, herring, mackerel, lobster, sea scallops, snow crab, squid, swordfish) in inshore and coastal areas of Nova Scotia. There are no location restrictions for harvesting gaspereau, clams (unspecified), eel, oyster, marine plants, seals, smelts and bluefin tuna. Pictou Landing First Nation also holds groundfish licences that include 3Pn in offshore Newfoundland as well as NAFO divisions in Nova Scotia (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Pictou Landing First Nation is made up of five small communities. The following table summarizes socioeconomic conditions based on publicly available information.

Table 7.48 Socioeconomic Overview of the Pictou Landing First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Pictou Landing First Nation and other agencies provide services and infrastructure such as health centre, a school, church and gas bar.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Pictou Landing's main industry is fishing with licenses in lobster, rock crab, snow crab, mackerel, herring and tuna. Pictou Landing has a fleet of 12 vessels and owns ancillary facilities in Cheticamp.	focused on the lands and waters of NS.	
Sources: KMKNO (undated)		

7.4.4.9 Potlotek First Nation

Potlotek First Nation, which was established in 1834, is one of the oldest reserves in Cape Breton. Chapel Island Reserve, formerly called Barra Head, was a traditional meeting place for the Mi'kmaq in the Maritimes (Potlotek First Nation Undated). Currently, the Potlotek First Nation has two Reserves, which are both located near St. Peter's. Potlotek First Nation is a member of the UNSI and represented by ANSMC in negotiations (INAC 2017).

The Registered First Nation population of Potlotek First Nation is close to 750. Approximately 76 percent of this population lives on the Potlotek Reserve lands (INAC 2017). The population of Potlotek First Nation is growing at a faster rate and younger than the Nova Scotia median age. According to 2016 census data, the Chapel Island Reserve population was 506 (SC 2017). No population information was available for Malagawatch.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes. The description that follows is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Potlotek First Nation holds FSC fishing licenses to harvest various species (i.e., capelin, cod, flounder, haddock, mackerel, mussel, pollock, shad and trout) within the inland and tidal waters of Cape Breton. Quahaug, smelt, soft-shelled clams are permitted in inland and tidal waters throughout Nova Scotia and striped bass may be fished in inland and tidal waters that border the Atlantic Ocean. Eel may be harvested in Antigonish Harbour and Bras d'Or Lake and salmon in the Margaree River and Estuary and North River. Potlotek also holds FSC licenses to fish for lobster around Cape Breton and scallop in coastal areas from Cape Breton to the southwest part of the province. Potlotek First Nation has FSC access to Atlantic salmon in Inverness and Victoria Counties, Cape Breton and bluefin tuna in the Gulf Region (Newbould 2017 pers comm; Belanger 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Potlotek First Nation and Apaqtukewag Fishermen's Co-op hold commercial-communal licences for snow crab, groundfish (unspecified), herring, lobster, sea urchin and northern shrimp. Most of these licences focus on the Cape Breton area but some extend to southwestern Nova Scotia and the Gulf of Maine. There are no location restrictions mackerel, squid, gaspereau, eel and bait (herring and mackerel) (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Potlotek First Nation is located near Port Hawksbury and St. Peter's. Thus, it can be expected that the small communities are connected socially and economically to the larger centres.

Table 7.49 Socioeconomic Overview of the Potlotek First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Potlotek First Nation and other agencies provide services and infrastructure such as housing, day care, preschool, elementary school, community hall/chapel, youth centre, policing, firefighting and medical centre. • Potlotek First Nation economic development initiatives include a store-gas bar, coffee shop, video lottery terminals. • Potlotek First Nation is engaged in commercial fisheries. The Nation owns and operates an oyster growing facility. The fisheries operation also manages lobster, snow crab, and tuna fishing with two fishing vessels that operate out of Glace Bay and Arichat.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: SC (2017); Potlotek First Nation (2016); KMKNO (Undated)		

7.4.4.10 Wagmatcook First Nation

Wagmatcook First Nation is located in the centre of Cape Breton Island and presently includes three reserves. Wagmatcook First Nation is a member of the UNSI and represented by the ANSMC in negotiations (INAC 2017).

The total First Nation Registered population of Wagmatcook First Nation was 869 in October 2017. Approximately 73 percent of the First Nations population lives on the Reserve lands (INAC 2017). Wagmatcook First Nation has a fast-growing population that is younger than the median age of the population of Nova Scotia generally (SC 2017). Population data were not available for Malagawatch and Margaree Reserves.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Wagmatcook First Nation. This discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Wagmatcook First Nation holds FSC fishing licenses to harvest various species (i.e., cod, eel, flounder, haddock, herring, mackerel, mussel, pollock, scallop, shad, smelt, trout) within inland and tidal waters of Cape Breton, Nova Scotia. Striped bass may be harvested in Bras d'Or Lake. Wagmatcook also holds licenses to harvest lobster around Cape Breton in LFA 27, 28, 29 and 30, which are located in Bras d'Or Lake and around Cape Breton. Salmon licences are held for areas of Inverness and Victoria Counties, Cape Breton including North River and portions of the Margaree River system (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Wagmatcook First Nation holds commercial-communal licences for groundfish (unspecified), snow crab, herring, lobster and sea urchin in coastal areas of Cape Breton and Nova Scotia as far as the Gulf of Maine. A licence for swordfish includes NAFO 3L, 3M, 3N, 3O and 3Ps in offshore Newfoundland as well as NAFO divisions off Nova Scotia. There are no location restrictions on gaspereau, eel, bait (herring and mackerel), mackerel, squid and seal. Wagmatcook First Nation also holds commercial-communal licences for crab (rock, spider/toad, snow), groundfish, lobster, mackerel, smelt, squid, swordfish and bluefin tuna in the Gulf Region (O'Neil 2017 pers comm, Belanger 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Wagmatcook First Nation is located near the Town of Baddeck. The community likely avails of regional services and participates in the regional economy.

Table 7.50 Socioeconomic Overview of the Wagmatcook First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Wagmatcook First Nation and other agencies provide services and infrastructure such as an all grades school, an alternative school for youth, day care, cultural centre and community cable TV. • Business initiatives include a business centre with a bank, post office, restaurant, sound stage/performance venue, gas bar, grocery store, wharf and warehouse. • A commercial fishing enterprise, which opened in 1990 by Wagmatcook Band, harvests groundfish, pelagic species and shellfish. The Band owns six lobster vessels, one groundfish vessel and, two storage facilities. An ice processing facility is co-owned by Wagmatcook Band.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Wagmatcook First Nation (2016); KMKNO (Undated)		

7.4.4.11 Waycobah First Nation

Waycobah First Nation, which is located in Cape Breton, was first established in the early 1800s, was originally known as We'ko'kmaq. This First Nation currently has two Reserves: Malagawatch and Whycocomagh. Waycobah First Nation is a member of the UNSI and represented by the ANSMC in negotiations (INAC 2017).

Waycobah First Nation had a Registered population of 1,000 in October 2017. About 89 percent lives on the Reserve lands (INAC 2017). The population of Whycocomagh Reserve is young and growing compared to the province of Nova Scotia in general (SC 2017). No data were available for Malagawatch Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Waycobah First Nation. This discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Waycobah First Nation holds FSC licenses to harvest various species (i.e., clam, cod, eel, flounder, haddock, mussel, pollock, quahaug, scallop, smelt and trout) within tidal and inland waters of Cape Breton. Shad may be harvested in the tidal waters of Nova Scotia generally. Mackerel and herring may be harvested in Fishing Areas 17, 18 and 19, which surround Cape Breton. Waycobah First Nation also holds FSC licenses to harvest lobster around Cape Breton and salmon in the Margaree River and Estuary and North River. Waycobah First Nation has FSC access to Atlantic salmon in Inverness and Victoria Counties, Cape Breton (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Waycobah First Nation holds commercial-communal licences for snow crab, groundfish (unspecified), herring, lobster, sea urchin and northern shrimp in coastal areas around Cape Breton and Nova Scotia as far as the Gulf of Maine. There are no location restrictions on eel, bait (herring and mackerel), mackerel and seal. Permitted areas for harvesting swordfish include NAFO 3L, 3M, 3N, 3O and 3Ps in offshore Newfoundland as well as NAFO divisions off Nova Scotia. Waycobah First Nation also has FSC access to bluefin tuna in the Gulf Region (O'Neil , 2017 pers comm; Belanger 2017, pers comm; Statoil 2017).

Other Socioeconomic Components

The following sections describe health and socioeconomic conditions using publicly available information. Limited information is available for some topics (Table 7.51).

Table 7.51 Socioeconomic Overview of the Waycobah First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Waycobah First Nation and other agencies provide services and infrastructure such as a school, health care centre, police station, fire department and recreation facilities. The Band Council owns a number of these facilities along with businesses such as a gas station,	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
convenience store, fitness facility and gaming facility. • Waycobah First Nation has commercial licences for lobster, shrimp, crab, groundfish and elver. The Band has inactive licenses for tuna, whelk, urchin, mackerel and herring. A trout farm has been established in Waycobah.		
Sources: Waycobah First Nation (Undated)		

7.4.4.12 Millbrook First Nation

During the late 1700s and the early 1800s, Mi'kmaq settled along the banks of the Salmon River near Truro. They were later relocated to their current reserve at Millbrook (Millbrook First Nation 2017). Millbrook First Nation includes seven Reserve lands near Truro and Halifax (i.e.,. Beaver Lake 17, Cole Harbour 30, Millbrook 27, Sheet Harbour 36, Truro 27A, Truro 27B, Truro 27C). Millbrook First Nation is a member of CMM. In 2016, Millbrook First Nation chose to independently represent themselves in consultation and is no longer a member of the ANSMC but still asserts the same rights as other Mi'kmaq communities in Nova Scotia (INAC 2017).

The total Registered Indian population of Millbrook First Nation was 663 in October 2017. About 48 percent live on Millbrook First Nation Reserve lands and some live on other reserves (INAC 2017). The populations of Millbrook First Nation communities show varying rates of growth. The Millbrook Reserve population is younger than that of the province overall (SC 2017). Some census data are suppressed for Beaver Lake and Sheet Harbour due to small populations. No census population data are available for Truro 27A, Truro 27B and Truro 27C.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Millbrook First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Millbrook First Nation holds FSC fishing licenses to harvest a variety of species (i.e., brown trout, chain pickerel, eel, grey trout, lake trout, rainbow trout, speckled trout, salmon, smallmouth bass, striped bass) within inland and tidal waters of Nova Scotia, including the Bay of Fundy. There are no location restrictions for fishing eel and smelt. Millbrook First Nation also holds FSC licenses for other species, including herring, lobster, mackerel, ocean quahaug, oyster and scallop in defined NAFO divisions in

and around Nova Scotia. Millbrook First Nation has FSC access to Atlantic Salmon in Cape Breton (Inverness County) as well as the northeastern counties of Antigonish, Pictou, Colchester and Cumberland (Newbould 2017, pers comm; Statoil 2017).

Commercial-Communal Fishing

Millbrook First Nation holds commercial-communal licences for clams (unspecified), Jonah crab, snow crab, herring, lobster and sea urchins in coastal and inland waters of Nova Scotia. There are no location restrictions for gaspereau, eel, bait (herring and mackerel), mackerel, seal and tuna. Groundfish and hagfish may be harvested in NAFO divisions off Nova Scotia. Millbrook First Nation holds swordfish licences in 3L, 3M, 3N, 3O and 3Ps in offshore Newfoundland as well as in NAFO divisions around Nova Scotia (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Limited information on the socioeconomic characteristics of the Millbrook First Nation was found to be publicly available. The following summarizes describe these characteristics based on the available information (Table 7.52).

Table 7.52 Socioeconomic Overview of the Millbrook First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Millbrook First Nation and other agencies provide services and infrastructure including housing, recreation facilities, a preschool, health centre, seniors centre, community hall and church. • Millbrook Reserve has a commercial business park on Highway 102. The development includes a service station, movie theatre, restaurants, hotel, retailers and heritage centre. Cole Harbour Reserve also has commercial businesses and infrastructure including apartment buildings, a business centre and gaming centre. • Millbrook Fisheries has eight vessels and 52 commercial-	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
communal licenses province-wide and an aquaculture facility.		
Sources: SC (2017); Millbrook First Nation (2017)		

7.4.4.13 Sipekne'katik First Nation

Sipekne'katik First Nation, established in 1820 as Indian Brook, is located in Hants County, Nova Scotia near Shubencadie. Sipekne'katik First Nation incudes five reserves (i.e., Indian Brook 14, New Ross 20, Pennal 19, Shubenacadie 13, Wallace Hills 14A) near Halifax and Truro. Sipekne'katik First Nation is a member of CMM. In 2013, this First Nation chose to represent themselves in consultation and negotiations, independently of ANSMC, and still asserts the same rights as other Mi'kmaq communities in Nova Scotia (INAC 2017).

Sipekne'katik First Nation had a total Registered Indian population of 2,665 in October 2017. Approximately 49 percent lives on Sipekne'katik First Nation Reserve lands (INAC 2017). Where data are available, the population of Sipekne'katik First Nation is younger than the median age for Nova Scotia and is experiencing growth (SC 2017). Some of the census data for New Ross, Shubenacadie and Pennel were not applicable or suppressed for confidentiality reasons.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available to describe current use of land and resources by Sipekne'katik First Nation. The following discussion of traditional activity is focused on harvesting of migratory marine associated species through FSC and commercial-communal fishing by the Sipekne'katik First Nation.

FSC Fishing

Sipekne'katik First Nation holds FSC fishing licenses to harvest a variety of species (i.e., bar calms, gaspereau, herring, landlocked salmon, mackerel, mussel, quahaug, razor clam, seal, smallmouth bass, soft-shell clam, striped bass and trout, within the inland and tidal waters of Nova Scotia. Salmon harvesting is permitted in the Margaree River and in Inverness, Colchester and Cumberland Counties. There are no location restrictions for eel, shad or smelt. Sipekne'katik First Nation also holds an FSC license to fish for crab (other than snow crab), lobster, scallops and groundfish in coastal and marine areas around Nova Scotia, including the Bay of Fundy and Gulf of St. Lawrence (Newbould, 2017 pers comm; Statoil 2017). The Sipekne'katik Fisheries Department has developed a Lobster Fishery Management Plan and also manages licenses for snow crab and groundfish (Sipekne'katik First Nation 2016).

Commercial-Communal Fishing

Sipekne'katik First Nation holds commercial-communal licences for clams, snow crab, groundfish (unspecified), lobster, sea scallops, sea urchins and swordfish in inland and / or tidal waters of the Bay

of Fundy, Northumberland Strait and coastal areas from Guysborough County to Halifax County. There are no location restrictions for harvesting tuna, gaspereau and bait (herring and mackerel) (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Sipekne'katik First Nation is mainly made up of small communities. Table 7.53 is based on the limited information that is publicly available on socioeconomic conditions.

Table 7.53 Socioeconomic Overview of the Sipekne'katik First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Sipenkne'katik First Nation and other agencies provide services and infrastructure such as housing, education, health care, recreation, housing and social needs. The community has a multi-purpose centre that provides fitness programs and facilities for community meetings, events and social gatherings. The Band council undertakes road work, building construction and maintenance, water and waste water treatment and solid waste and recycling. • Local businesses include a gas-bar, smoke shop, gaming room and convenience store. • The Fisheries Department manages 33 fishing licenses for lobster, snow crab, and groundfish.	• A general description of the history and culture of the NS Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NS.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Sipekne'katik First Nation (2016)		

7.4.4.14 Traditional Use / Fisheries Studies Undertaken as Part of Recent Offshore Exploration Drilling Projects in Atlantic Canada

In 2014, Membertou Geomatics Solutions and Unama'ki Institute of Natural Resources prepared a Traditional Use Study (TUS) for the Shelburne Basin Venture Exploration Drilling Project for Shell Canada Limited. The regional assessment area (RAA) for the Project was restricted to the 200-nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotia Shelf and Slope within

Canadian jurisdiction. The RAA extended from Banquereau Bank off Cape Breton to the United States border including the coastline of southwest Nova Scotia but not the Bay of Fundy (MGS & UINR 2014). The TUS report discusses the presence and land use activities of the Mi'kmaq for more than 10,000 years.

The TUS report states that no FSC harvesting occurs within the previously described RAA. The report provides information on current FSC activities and indicates that the activities of several First Nations (i.e., Bear River, Glooscap and Shubenacadie) were not available. The summary indicates that Atlantic salmon and American eels are harvested by Nova Scotia Mi'kmaq year-round outside of the RAA and that the Native Council of Nova Scotia also harvests American eels year-round and Atlantic salmon between January 1 to November 15 (MGS & UINR 2014).

The TUS report states that five unspecified Nova Scotia Mi'kmaq communities held commercial communal licences for locations within the RAA. These include summer / fall fishing for bluefin tuna (August to November) and swordfish (September to November). American eels are harvested year-round but outside of the RAA. The Native Council of Nova Scotia held licences to harvest bluefin and big eye tuna (June to November) and swordfish (June 1 to October 30) within the RAA. In, addition, an unidentified New Brunswick Maliseet community has commercial-communal licences to harvest bluefin tuna, big eye tuna and swordfish from June to September and yellow fin tuna from March to December, within the RAA (MGS & UINR 2014).

In addition, in 2016 Membertou Geomatics Solutions and Unama'ki Institute of Natural Resources prepared a similar TUS for the Scotian Basin Exploration Drilling Project for BP Canada Energy Group ULC. The regional study area (RSA) for the Project was restricted to the 200-nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction. The RAA included Banquereau Bank off Cape Breton to the United States border including the coastline of Nova Scotia from Gabarus in Cape Breton to Yarmouth in southwest Nova Scotia (MGS & UINR 2016). The TUS report likewise presents information on the presence and land use activities of the Mi'kmaq and Maliseet for more than 10,000 years.

The TUS report states that all 13 Nova Scotia Mi'kmaq groups have commercial-communal harvesting licences within the previously described RSA. Eight of these First Nations (i.e., Acadia, Eskasoni, Millbrook, Pictou Landing, Glooscap, Membertou, Potlotek, Paq'tnkek Mi'kmaq) harvest species including American eels (year-round), bluefin tuna (August to November) and swordfish (September to November) within the RSA. The Native Council of Nova Scotia harvests several species of tuna (i.e., albacore, bluefin, big eye and yellowfin) from June to November and swordfish from June to October (MGS & UINR 2016).

Nova Scotia Mi'kmaq groups harvest 34 fish species for FSC purposes within the identified RSA and other areas. American eels, Atlantic salmon and tuna (unspecified) are harvested year-round for FSC purposes in the RSA. The Native Council of Nova Scotia harvests Atlantic salmon from January 1 to November 15 within the RSA and American eels year-round in other areas (MGS & UINR 2016).

Three New Brunswick First Nations participated in the TUS: Fort Folly (Mi'kmaq), Saint Mary's (Maliseet) and Woodstock (Maliseet) (see next sections of this EIS). These groups are engaged in commercial communal fisheries for several tuna species: bluefin (June to September), big eye and yellowfin tuna (June to November) and swordfish (June 1 to October 30) within the RSA. American eels

are harvested year-round outside of this RSA in unspecified areas (MGS & UINR 2016). The participating New Brunswick groups did not identify any migratory species as being harvested for FSC purposes either within or beyond the RSA.

7.4.5 Mi'kmaq First Nations of New Brunswick

New Brunswick is home to three Indigenous Nations (the Mi'kmaq, Maliseet and Passamaquoddy). This section describes the nine Mi'kmaq First Nations. The locations of these First Nations are shown in Figure 7.87 and the communities are described in further detail in the following sections. Refer to Section 7.4.4 for additional information on the general history of the Mi'kmaq. The Maliseet (also known as Wolastoqiyik) are described in more detail in Section 7.4.6 and the Passamaquoddy (also known as Peskotomuhkati) in Section 7.4.7.

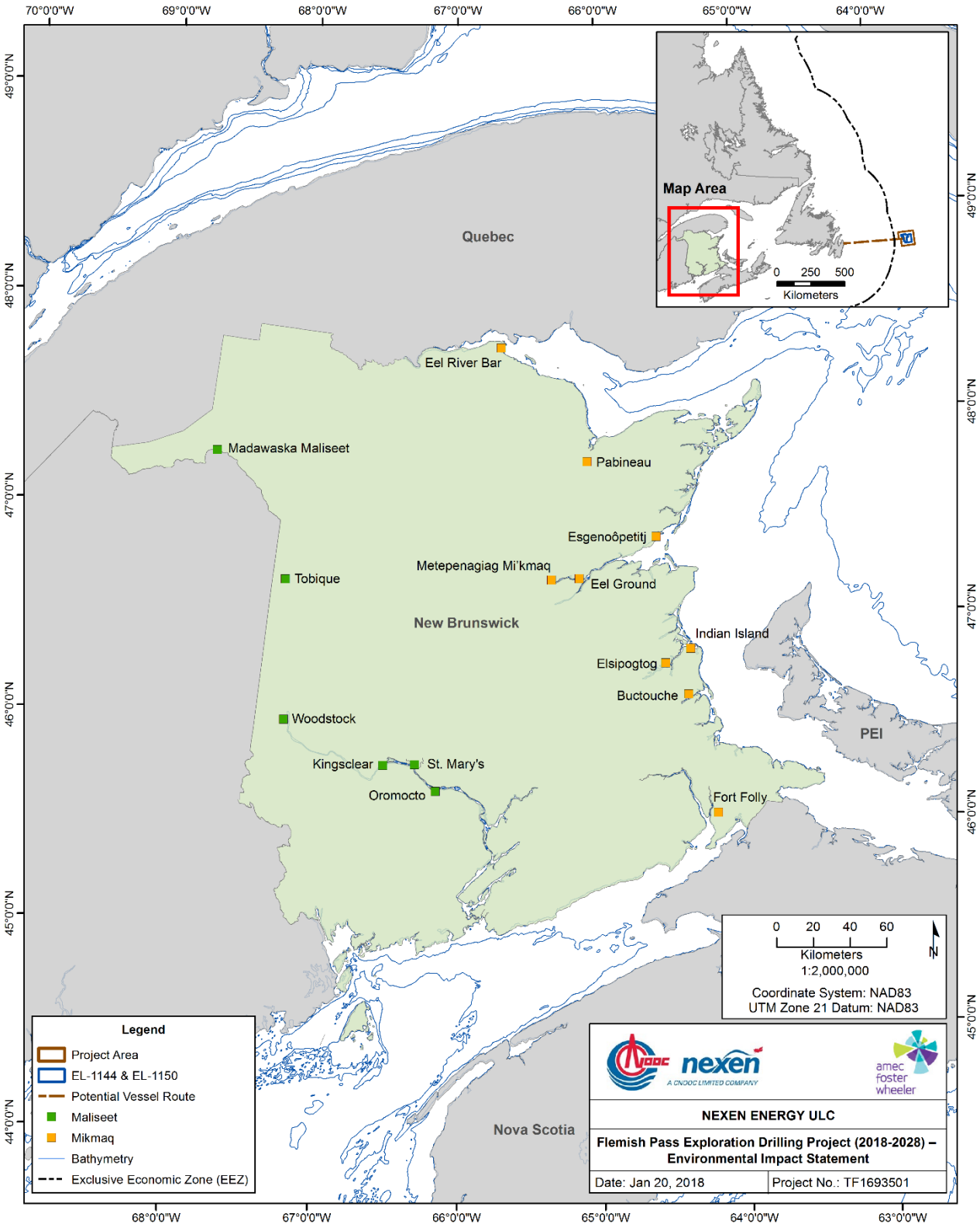
Seven of these Mi'kmaq First Nations are members of the North Shore MicMac District Council (NSMDC), which was established in 1987 to provide advisory and technical assistance to member First Nations. Originally, this assistance included finance, capital works (i.e., water and sewer), economic development and Band governance, and has been expanded to include post-secondary education, child and family services, housing inspection, human resources, Indigenous fisheries and other services. The other two Mi'kmaq First Nations are members of the Mawiw Tribal Council, which provides services in education, health care and healing to member communities (NBAA 2017; NSMDC Undated; INAC 2017).

As discussed previously, between 1725 and 1779 the British Crown signed several Peace and Friendship Treaties with the Mi'kmaq, Maliseet and Passamaquoddy, the terms of which were intended to establish peace and commercial relations. As affirmed by various recent Supreme Court decisions, the treaties guarantee Aboriginal rights to hunt and fish throughout the region and to maintain a moderate livelihood from these resources. These rights are protected under Section 35(1) of the *Constitution Act, 1982* (INAC 2017).

Exploratory discussions have been ongoing since 2002 between nine New Brunswick Mi'kmaq First Nations (i.e., Bouctouche, Esgenoôpetitj, Eel Ground, Eel River Bar, Fort Folly, Indian Island, Kingsclear, Metepenagiag Mi'kmaq, Pabineau), two Maliseet First Nations (i.e., Oromocto and Tobique) and the provincial and federal governments. The Assembly of First Nations' Chiefs in New Brunswick (AFNCNB) was established in 2007 to represent these First Nations in negotiation and consultation processes and has since been dissolved.

In 2011, the Governments of Canada, New Brunswick and the First Nations signed the Mi'kmaq Wolastoqiyik (Maliseet)/New Brunswick/Canada Umbrella Agreement. This Agreement establishes a process to guide discussions towards the conclusion of a Framework Agreement on Aboriginal treaty rights and self-government and a consultation agreement. In 2014, the parties signed the Mi'kmaq Wolastoqiyik/New Brunswick/Canada Interim Consultation Protocol to facilitate consultation activities undertaken by governments with the signatory Mi'kmaq and Maliseet First Nations. The parties are currently finalizing a Framework Agreement (INAC 2017).

Figure 7.87 Indigenous Communities in New Brunswick



The Mi'gmawe' Tplu'taqn Incorporated (MTI) currently represents eight of the nine M'kmaq communities in New Brunswick (the exception is Elipogtog First Nation). MTI is a not-for-profit organization established to manage consultation for member Mi'kmaq First Nations and to support the recognition and implementation of the Aboriginal and Treaty Rights of its members. Elsipogtog First Nation (Mi'kmaq) conducts its own consultation and engagement, and in 2016 launched an Aboriginal title claim to the southeastern third of the province (INAC 2017).

The Mi'kmaq First Nations are geographically focused in the eastern part of New Brunswick and known to occupy and use the land and waters around New Brunswick including use for travel corridors, hunting, harvesting and fishing for traditional purposes. The discussion of current use of lands and resources for traditional purposes is focused on activities in the marine environment. Therefore, the current use of lands and resources for traditional purposes section is focussed on a discussion of FSC and commercial-communal harvesting.

The following sections describe the New Brunswick Mi'kmaq First Nations. These are outlined in terms of a general overview followed by a description current use of land and resources for traditional purposes and a summary health and socioeconomic conditions and physical and cultural heritage resources.

7.4.5.1 Fort Folly First Nation

Fort Folly First Nation is located near Dorchester, New Brunswick. The First Nation has one Reserve: Fort Folly 1. Fort Folly First Nation is a Mi'kmaq Nation affiliated with the NSMDC and represented in consultation and engagement by MTI (NSMDC Undated; INAC 2017).

The Registered Indian population of Fort Folly First Nation was 132 in October 2017. Of the total Registered Indian population, 27 percent live on Reserve (INAC 2017). The population of Fort Folly First Nation experienced decline between the 2011 and 2016. The median age (38 years) of this First Nation was higher than many of the other identified First Nations communities in Eastern Canada (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Fort Folly First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Fort Folly First Nation holds FSC fishing licences for lobster in the Bay of Fundy (Statoil 2017).

Commercial-Communal Fishing

Fort Folly First Nation holds commercial-communal licences for groundfish (unspecified), herring, lobster and sea scallop in inshore areas. There are no location restrictions for fishing gaspereau, eel, bait (herring and mackerel) and tuna. Fort Folly First Nation holds swordfish licences for various areas

including NAFO 3L, 3M, 3N, 3O in offshore Newfoundland and 3Ps off southern Newfoundland as well as NAFO divisions around Nova Scotia and the Gulf of Maine (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.54 Socioeconomic Overview of the Fort Folly First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Fort Folly First Nation and other agencies provide services and infrastructure including a pre-school, • Fort Folly First Nation economic initiatives include commercial fishing particularly for lobster and scallops. The First Nation has two lobster boats.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Fort Folly First Nation (Undated)		

7.4.5.2 Eel Ground First Nation

Eel Ground First Nation is located in New Brunswick on the Miramichi River. The First Nation has three reserves near Newcastle: Big Hole Tract 8 (South Half), Eel Ground 2 and Renous 12. Eel Ground First Nation is affiliated with the NSMDC and represented in consultation and engagement by MTI (INAC 2017).

In October 2017, Eel Ground First Nation had a Registered Indian population of 1,069. Approximately 55 percent lived on the Reserves (INAC 2017). Eel Ground First Nation is experiencing population growth at a much higher rate than the New Brunswick population in general. The population is also younger than the provincial median population (SC 2017). No census population data were available for Renous 12 Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Eel Ground First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Eel Ground First Nation holds FSC licences for clams, mussels, eel, gaspereau, herring, mackerel, oysters, quahaug, salmon, shad, smelt, striped bass and brook trout. Clams, mussels, oysters and quahaug may be harvested in tidal waters of Northumberland County and herring and mackerel, in the Northumberland Strait. Eel, gaspereau, salmon, shad smelt, striped bass and brook trout licences are for tidal and / or inland portions of the Miramichi River system (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Eel Ground First Nation holds commercial-communal licences for herring, lobster, mackerel and snow crab in the Gulf of St. Lawrence mainly in the southern portion and Northumberland Strait. Groundfish licences are held for the Gulf of St. Lawrence and 3Pn in southwest Newfoundland. There are no location restrictions for gaspereau, American oysters, sea urchins, soft-shell clam and marine plants (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.55 Socioeconomic Overview of the Eel Ground First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Eel Ground First Nation and other agencies provide services including education, health care, housing, a school, a health and wellness centre, solid waste management • Eel Ground First Nation is engaged in fisheries and forestry as well as retail services.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Eel Ground Health and Well Centre website (2017); EGFN (2017)		

7.4.5.3 Pabineau First Nation

Pabineau First Nation, and other Mi'kmaq people, has a long history of fishing Atlantic salmon in the Little River system (PFN Undated). Pabineau Reserve is located near Bathurst in northern New Brunswick. Pabineau First Nation is a Mi'kmaq Nation affiliated with the NSMDC and represented in consultation and engagement by MTI (INAC 2017).

The Registered First Nations population of Pabineau was 314 in October 2017. Of these, approximately 33 percent were living on the Reserve (INAC 2017). Pabineau First Nation has a relatively young population. The First Nation experienced a population decline in the 2011 to 2016 census period (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Pabineau First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Pabineau First Nation holds FSC licences for clams (i.e., soft-shell, bar, razor), mussels and oysters in tidal waters bordering Restigouche and Gloucester Counties. FSC licences are also held for herring in the Bay of Chaleur and mackerel in the Gulf of St. Lawrence. Trout may be harvested in various rivers (e.g., Nepisiguit, Pabineau, Middle, Tetagouche, Charlo, Benjamin, Upsalquitch) and related tributaries and lakes. Pabineau First Nation has FSC access to salmon in the systems of the Nepisiguit, Upsalquitch, Middle, Tetagouche and Nigadou Rivers (Belanger 2017, pers comm; Statoil 2017).

Commercial-Communal Fishing

Pabineau First Nation holds commercial-communal licences for rock crab in an area northeast of Cape Breton. Herring, lobster, mackerel, sea scallops and snow crab may be harvested in the Gulf of St. Lawrence including coastal areas around the Northumberland Strait and Western Newfoundland. Pabineau First Nation also holds groundfish licences for areas to the south of Newfoundland and the Gulf of St. Lawrence. There are no location restriction for harvesting American oysters or bluefin tuna (Belanger 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.56 Socioeconomic Overview of the Pabineau First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Pabineau First Nation and other agencies provide services and infrastructure including housing, daycare, education, recreation, drinking water, seniors' services, public utilities, power line management, a	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
health centre, environmental protection, land use planning and a community kitchen. Community health issues include diabetes care, alcohol and drug abuse. • Pabineau First Nation economic initiatives include an industrial park, a restaurant, smoke shop and gas station and tourism amenities. • Pabineau First Nation is involved in an Atlantic salmon counting and brood stock collection fence on the Nepisiguit and Pabineau River.		
Sources: PFN (Undated)		

7.4.5.4 Esgenoôpetitj First Nation

Esgenoôpetitj First Nation, formerly known as Burnt Church First Nation, located in northern New Brunswick near Chatham and Bathurst. Esgenoôpetitj First Nation has three reserves (i.e., Esgenoôpetitj Tribal Reserve 14, Pokemouche 13, Tabusintac 9). Esgenoôpetitj First Nation is affiliated with the Mawiw Council and represented in consultation and engagement by MTI (INAC 2016; NBAA 2017).

The October 2017 population of Esgenoôpetitj First Nation was 1,915 individuals. Nearly 79 percent live on Esgenoôpetitj Reserve lands. The population of Esgenoôpetitj First Nation is experiencing growth. This First Nation's population is also younger than the population of the New Brunswick population overall (SC 2017). Some of the census data for Tabusintac were suppressed for confidentiality and no data were available for Pokemouche.

Current Use of Lands and Resources for Traditional Purposes

Limited information was available publicly on current land and resource of the Esgenoôpetitj First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Esgenoôpetitj First Nation holds FSC licences for harvesting eels, salmon, striped bass, trout and sea run brook trout in New Brunswick Rivers (e.g. Miramichi, Tabusintac, Burnt Church, Bartibog). Lobster may be harvested in the Gulf of St. Lawrence near New Brunswick. No specific locations were identified for harvesting soft-shell clams, bar clams, quahaugs, herring, mackerel, mussels, oysters and smelts (Belanger 2017, pers comm; Statoil 2017).

Commercial-Communal Fishing

Esgenoôpetitj First Nation holds commercial-communal licences for, rock crab, spider / toad crab, herring, lobster, mackerel, sea scallops and snow crab in areas of the Gulf of St. Lawrence and near Cape Breton. Groundfish species are harvested in the Gulf of St. Lawrence and off southwestern Newfoundland. No location restrictions are identified for harvesting bar clams, eels, marine plants, mussels, American oysters, quahaugs, smelts, soft-shell clams or bluefin tuna (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Esgenoôpetitj First Nation Reserves are located near the larger urban centres of Bathurst and Chatham and are likely closely connected in terms of access to services in the larger communities.

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.57 Socioeconomic Overview of the Esgenoôpetitj First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Esgenoôpetitj First Nation and other agencies provide services and infrastructure such as housing, a school, a fire hall, solid waste management and policing.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: INAC (2012b); RCMP (2017).		

7.4.5.5 Bouctouche First Nation

Bouctouche First Nation Reserve is located on the east coast of New Brunswick. The Reserve was established in 1810, abandoned in 1924 and re-established in 1958. It is thought that the Band's traditional fishing, trapping and hunting territories encompassed the western third of PEI, followed the coast of NB from Miramichi Bay along the Northumberland Strait, southeast between NS on the Bay of

Fundy to the border of Maine. During the winter months, this territory also stretched inland to areas around Fredericton, Grand Lake, Moncton and Miramichi (Buctouche First Nation Undated).

Bouctouche First Nation presently has one Reserve: Buctouche 16. The First Nation is a member of NSMDC and represented in consultation and engagement by MTI. The Registered population of Bouctouche First Nation in October 2017 was 122. Approximately 68 percent of these (78 individuals) live on the Buctouche Reserve (INAC 2017; NSMDC Undated). The population of Buctouche Reserve is young and growing. The median age of the population is lower and the percentage of population under 15 years is higher than that of New Brunswick in general (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Bouctouche First Nation. This discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Bouctouche First Nation holds FSC licences for striped bass and sea run trout in Crown open waters of New Brunswick. Mackerel may be harvested in the Northumberland Strait of the Gulf of St. Lawrence. Salmon may be harvested in the Miramichi River and eels in the Buctouche River and coastal areas near Reserve lands (Belanger, 2017 pers comm; Statoil 2017). Harvesting locations were not available for clams and oysters.

Commercial-Communal Fishing

Bouctouche First Nation holds commercial-communal licences for rock crab, herring, lobster, mackerel, sea scallop and snow crab for areas of the Gulf of St. Lawrence especially the southern part near Prince Edward Island and the Northumberland Strait. Spider / toad crab may be harvested in an area to the south west of Cape Breton. Shark (porbeagle / mackerel) may be harvested throughout the Gulf of St. Lawrence. Inshore groundfish licences are held for 3Pn (southwest Newfoundland) and other areas of the Gulf of St. Lawrence and the Cabot Strait (Belanger, 2017 pers comm; Statoil 2017). Bouctouche First Nation also holds FSC licences for gaspereau, bar clams, American oysters, seal and smelt but no specific areas were identified.

Other Socioeconomic Components

Bouctouche First Nation is a small community and limited data and information were available to describe conditions. The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.58 Socioeconomic Overview of the Buctouche First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Bouctouche First Nation and other agencies provide services and infrastructure such as housing, a school and fire hall. • Bouctouche First Nation economic initiatives include commercial-communal fishing, forestry and a gas station • Given the distance of the Project from New Brunswick it is not likely to interact with community infrastructure and activities of Buctouche First Nation.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Bouctouche First Nation (Undated); SC (2017); First Nation Education Initiative Inc. (Undated); INAC (2017)		

7.4.5.6 Indian Island First Nation

Indian Island First Nation is located in eastern New Brunswick on the Richbucto River and has one reserve: Indian Island 28, which is located near Rexton. Indian Island First Nation is a member of the NDNDC and represented in consultation and engagement by the MTI (NSMDC Undated).

In October 2017, Indian Island First Nation had a Registered First Nation population 194. Approximately 56 percent of these live on the Reserve (INAC 2017). Indian Island First Nation experienced growth between 2011 and 2016. The population is younger than that of the province of New Brunswick overall (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Indian Island First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Indian Island First Nation holds FSC licences for clams (soft-shell, bar and razor), mussels, oysters, quahaugs and smelts in the waters of Richibuctou Harbour; lobster and rock crab in LFA 25, which is in the Northumberland Strait; salmon, herring and mackerel in the waters of the Northumberland Strait; and eel, striped bass and trout in the Richibuctou River system. Gaspereau may be harvested as by-catch using the same gear as used for catching salmon (Belanger 2017, pers comm; Statoil 2017).

Commercial-Communal Fishing

Indian Island First Nation holds commercial-communal licences for sea scallops, rock crab and lobster in the Northumberland Strait; herring and mackerel in the Northumberland Strait and Bay of Chaleur; groundfish in 3PN off southern Newfoundland along with areas of the Gulf of St. Lawrence and Cape Breton; and snow crab in the Gulf of St. Lawrence. There are no specific location restrictions for harvesting gaspereau, American oysters, eels, smelts, soft-shelled clams and bluefin tuna (Belanger 2017, pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.59 Socioeconomic Overview of the Indian Island First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Indian Island First Nation and other agencies provide services and infrastructure including housing, road maintenance, fire protection, policing, ambulance service, garbage collection, emergency management and recreation amenities. • Indian Island First Nation economic initiatives include an oyster grow-out facility.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Source: Indian Island First Nation (2015)		

7.4.5.7 Eel River Bar First Nation

Historically, Mi'kmaq families would complete their annual migration at a summer encampment in the area around Benjamin and Eel Rivers. The banks of the Benjamin River provided rich farming land and the Eel River provided a variety of fish. The area provided convenient access to Heron Island, where traditional burials took place. The Eel River Bar community harvested the resources of the land, oceans, lakes and rivers, which provided a variety of fresh fish (e.g., salmon and eels), seals, shellfish, moose, deer, bear, small animals and birds. The people fished in the waters of the Bay of Chaleur and dug for clams on the sandy shores of Eel River Bar. In 1963, the construction of a dam in the Eel River resulted in flooding and loss of fishing and gathering clams on the sandy shores of the Eel River (Eel River Bar First Nation 2017).

Eel River Bar First Nation is located in northeastern New Brunswick on the Bay of Chaleur. The First Nation currently has three reserves near Dalhousie, New Brunswick (i.e., Eel River 3, Indian Ranch,

Moose Meadows 4). Eel River Bar First Nation is a Mi'kmaq Nation affiliated with the NSMDC and represented in consultation and engagement by the MTI (INAC 2017; NSMDC Undated).

Eel River Bar First Nation had a total Registered population of 743 in October 2017. Approximately 47 percent live on Reserve land belonging to Eel River Bar First Nation and a small number live on other reserves (INAC 2017). The population of Eel River Bar First Nation is young and growing (SC 2017). Census data are not available for Moose Meadows Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Eel River Bar First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Eel River Bar First Nation holds FSC licences for soft-shell clam in the tidal waters of Restigouche County. Herring and salmon may be harvested in the Bay des Chaleurs, and salmon licences also include the Restigouche River system, Benjamin River, Charlo River, Jacquet River and Eel River. Lobster and rock crab may be harvested in coastal areas adjacent to Eel River Bar Reserve 3 (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Eel River Bar First Nation holds commercial-communal licences for a variety of species (i.e., rock crab, herring, lobster, mackerel, sea scallops and snow crab) in inshore areas of the Gulf of St. Lawrence particularly in southern portions and the Northumberland Strait. Licences are held for mussels, American oysters, sea urchins, northern shrimp and bluefin tuna in unspecified coastal and inshore areas. Eel River Bar First Nation also holds commercial-communal licences for groundfish in 3Pn (southwest Newfoundland) and the Gulf of St. Lawrence (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.60 Socioeconomic Overview of the Eel River Bar First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Eel River Bar First Nation and other agencies provide services and infrastructure such as housing and a school.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Eel River Bar First Nation members make a living from traditional resource industry jobs such as fishing and forestry, and within First Nation local government, housing construction, trades, small business, and band-based business operations.	focused on the lands and waters of NB.	
Sources: Eel River Bar First Nation (2017)		

7.4.5.8 Metepenagiag Mi'kmaq First Nation

Metepenagiag Mi'kmaq First Nation is located on the Miramichi River near Newcastle, New Brunswick. The Miramichi River has long served as a travel route and meeting point for the Mi'kmaq people in New Brunswick (MMFN undated). This First Nation has three reserves: Indian Point 1, Red Bank 4 and Red Bank 7 as well as a portion of Big Hole Tract 8 (North Half). Metepenagiag First Nation is affiliated with the NSMDC and represented in consultation and engagement by MTI (INAC 2017).

In October 2017, the Registered Indian population of Metepenagiag Mi'kmaq First Nation was 683. Of which, approximately 64 percent lived on Reserve lands (INAC 2017). The population of Metepenagiag Mi'kmaq First Nation declined during the most recent census period. The population is younger than that of the province of New Brunswick in general, based on available data (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Metepenagiag Mi'kmaq First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Metepenagiag First Nation holds FSC licences for eel, salmon, shad, striped bass and sea run brook trout. These species may be harvested in coastal waters near the Reserve lands or in the Miramichi River System of New Brunswick (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Metepenagiag First Nation holds commercial-communal licences for lobster, rock crab, sea scallops and herring in inshore areas of Prince Edward Island in the Northumberland Strait; and mackerel and snow crab in the Gulf of St. Lawrence. There are no location restrictions for harvesting gaspereau, American oysters and northern shrimp (Belanger 2017, pers comm; Statoil 2017).

Other Socioeconomic Components

Like many First Nations communities discussed in this report, Metepenagiag Mi'kmaq First Nation is made up of several Reserves with small populations. The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.61 Socioeconomic Overview of the Metepenagiag Mi'kmaq First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Metepenagiag Mi'kmaq First Nation and other agencies provide services and infrastructure such as housing, a school and policing.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • Metepenagiag Mi'kmaq First Nation and the New Brunswick Mi'kmaq, are known to occupy and use the lands and waters around New Brunswick and especially in the Miramichi area.	• Archeological findings show that the Miramichi area has been continuously inhabited by the Mi'kmaq people for more than 3,000 years. • Two sites have been identified as National Historic Sites of Canada. Metepenagiag Mi'kmaq Nation has developed a heritage park. • Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: GMRSC (Undated); Metepenagiag Mi'gmaq Nation (Undated); Parks Canada (Undated)		

7.4.5.9 Elsipogtog First Nation

Elsipogtog First Nation, formerly known as Big Cove Band, includes two reserves: Richbucto 15 and Soegao 35. The Richbucto Reserve is located on the Richbucto River and the Soegao Reserve is near Moncton. Elsipogtog First Nation is a Mi'kmaq Nation affiliated with the Mawiw Council (NBAA 2017).

The total Registered First Nations population was 3,338 in October 2017. Approximately 77 percent of these live on Elsipogtog First Nation Reserves (INAC 2017). Elsipogtog First Nation, like other New Brunswick Indigenous communities, has a relatively young population. The First Nation experienced a population decline during the last census period. Census data were not available for Soegao (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Elsipogtog First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Elsipogtog First Nation holds FSC licences for a number of species. Clams (bar, razor, soft-shell), mussels, oysters, quahaugs and trout may be harvested in tidal waters of New Brunswick including the Gulf of St. Lawrence and Northumberland Strait. Elsipogtog First Nation has FSC access to eels, gaspereau, shad, smelts and striped bass in New Brunswick river systems, including the Richibuctou, Kouchibouguac, Aldouane, Molus, St. Nicholas and Black Rivers and Atlantic salmon in the Miramichi River system. In addition, herring, lobster, mackerel, rock crab, scallop and seals may be harvested in the Gulf of St. Lawrence and especially in the Northumberland Strait (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Elsipogtog First Nation holds commercial-communal licences for rock crab, herring, lobster, mackerel, snow crab and sea scallops in areas of the Gulf of St. Lawrence. Groundfish licences are held for areas to the southwest of Newfoundland and the Gulf of St. Lawrence. No location restrictions are identified for gaspereau, bar clams, eels, marine plants, mussels, American oysters, quahaug, seals (unspecified), smelts, soft-shell clams and bluefin tuna smelt, snow crab, soft-shell clam and bluefin tuna (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.62 Socioeconomic Overview of the Elsipogtog First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Elsipogtog First Nation and other agencies provide services and infrastructure such as housing, police detachment, fire hall and a school. • Elsipogtog First Nation economic initiatives include a supermarket and pharmacy.	• A general description of the history and culture of the NB Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: CNW (2017); Elsipogtog First Nation (Undated); First Nation Education Initiative Inc. (Undated)		

7.4.6 Maliseet First Nations of New Brunswick

The Maliseet (also Wolastoqiyik) are a branch of the Algonquin peoples and the original inhabitants of the Saint John River Valley and its tributaries. As with most nations with Algonquin ties, the Maliseet hold similar spiritual views as the Mi'kmaq with deep connections to the land and waters. The Maliseet have similar customs and language to those of the Passamaquoddy and Penobscot peoples, with whom they have also shared lands. A primary difference among these peoples is that the Maliseet traditionally pursued an agrarian economy. At the time of the first encounter with Europeans, the Maliseet were primarily agricultural, supplementing their diet with hunting, fishing and gathering fruits, berries and nuts (Wolastoqiyik, 2016; MMFN Undated; C. Gagnon 2006).

The history of the Maliseet people was recorded in European transcripts and thus best reflects the post contact period. The earliest written records came from French missionaries in the late 1600s who documented the existence of people they called the Etchemins, which included the Maliseet and Passamaquody nations. One account noted that the people were located at the mouth of the Madawaska River for the purpose of hunting. Another record described the same settlement at the mouth of the Madawaska River and indicated that there were nine other Indian settlements in the area; three on the Aroostook River, four on the Saint. John River, one on Eagle Lake and one on the Squateck Lake (C. Gagnon 2006).

New Brunswick currently has six Maliseet First Nations, each of which are described in more detail below. Four of the New Brunswick Maliseet First Nations are members of the Wolastoqey Tribal Council Inc (St. Mary's, Oromocto, Kingsclear, Madawaska), and five of the six (St. Mary's, Oromocto, Kingsclear, Madawaska, Tobique) are members of the Wolostoqey Nation of New Brunswick (WNNB). The locations of Indigenous reserves are provided in Figure 7.87.

The British took control of former French lands in Atlantic Canada in 1758. At that time, the Maliseet petitioned the Governor of Canada (Québec) to request that the British respect their rights to specific territory in the Upper Saint. John River Valley, between the Grand Falls and Lake Témiscouata including Rivière du Loup and the Madawaska River that had been recognized by the French. In particular, the Maliseet indicated that British encroachment was adversely affecting their ability to hunt beaver. In 1765, the Governor confirmed the Maliseet rights over the area. The British later granted lands in Maliseet territory to Loyalists and this area was also settled by Acadians fleeing from the British (Gagnon 2006).

As discussed, the Peace and Friendship Treaties were established between 1725 and 1779 between the Mi'kmaq, the Maliseet, the Peskotomuhkati and British, the terms of which were intended to establish peace and trade relations (INAC 2017). As affirmed by recent Supreme Court decisions, these treaties guarantee rights to hunt and fish throughout the region and to maintain a moderate livelihood.

The Maliseet are known to occupy and use the land and waters around New Brunswick including use for travel corridors, land hunting and harvesting, and fishing for traditional purposes. The discussion of current use of lands and resources for traditional purposes is focused on activities in the marine environment and species of interest to New Brunswick Indigenous communities that may migrate through the marine environment off Eastern Newfoundland. The current use of lands and resources section therefore includes a discussion of FSC and commercial-communal harvesting.

7.4.6.1 Kingsclear First Nation

The community of Kingsclear was officially established in 1795. Prior to settling at its current location, the Maliseet people lived in a village called Ekwpahak, located a few miles downriver. This area was occupied in the late spring and summer when the Maliseet speared salmon, bass and sturgeon, planted corn and gathered foods and medicines such as fiddleheads, berries, butternut, grapes and wild potatoes (Kingsclear First Nation 2014).

Kingsclear First Nation is located along the Saint John River, approximately 15 km west of Fredericton. Kingsclear has two Reserves: Kingsclear and The Brothers 18. The latter is located on two small islands in Kennebecasis Bay and also affiliated with Woodstock, Tobique and Madawaska First Nations. Kingsclear First Nation is a member of Wolastoqiyik Nation and represented in consultation by the WNNB (INAC 2017).

In October 2017, Kingsclear First Nation had a Registered Indian population of 1,042. Approximately 70 percent live on Reserve lands (INAC 2017). Like many other First Nations communities in New Brunswick, Kingsclear has a young and growing population, though the population increase between 2011 and 2016 was not as high as in other communities (SC 2017). No census data were available for The Brothers 18 Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Kingsclear First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Kingsclear First Nation holds FSC fishing licenses for striped bass and lobster. Striped bass fishing is limited to the portion of the Saint John River from the head of the tide at McKinley Ferry to the Mactaquac Dam. Lobster harvesting occurs in LFA 36 and 38, located along the New Brunswick coast. Kingsclear First Nation has FSC access to Atlantic salmon in the Saint John River, New Brunswick (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Kingsclear First Nation holds commercial-communal licences for rock crab, lobster, sea scallops and sea urchins for the Bay of Fundy. Groundfish (unspecified) licences are held for NAFO areas off southwestern Nova Scotia and the Gulf of Maine. Herring may be harvested in coastal waters off Nova Scotia from Cape Breton to the Bay of Fundy (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.63 Socioeconomic Overview of the Kingsclear First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Kingsclear First Nation and other agencies provide services and infrastructure such as housing, a school, a health centre, home care, addictions programs, dental care, fire department, medical first response and others. • Kingsclear First Nation economic initiatives include a convenience store, commercial fishery and forestry.	• A general description of the history and culture of the NB Maliseet is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Archaeological evidence dated at approximately 11,000 years old demonstrates the history of the Maliseet in the Saint John River area. • Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Kingsclear First Nation (2014)		

7.4.6.2 Madawaska Maliseet First Nation

Madawaska Maliseet First Nation, located in Northwest New Brunswick, has two Reserves, St. Basile and The Brothers 18. The Brothers 18 is located on two small islands in Kennebecasis Bay and also affiliated with Kingsclear First Nation, Tobique First Nation, and Woodstock First Nation. Madawaska is affiliated with Wolastoqey Tribal Council and represented in consultation by the WNNB (INAC 2017).

Madawaska Maliseet First Nation had a Registered population of 371 in October 2017. Of these, approximately 41 percent lived on the Reserve (INAC 2017). Madawaska Maliseet First Nation had a total population of 214 in 2016, which was a greater than 24 percent increase over 2011. The median age of the population was nearly as high as that of New Brunswick in general, which is atypical of New Brunswick First Nations (SC 2017). No census data were available for The Brothers 18 Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Madawaska Maliseet First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Madawaska Maliseet First Nation holds FSC licences for lobster in the Gulf of St. Lawrence. Salmon may be harvested in various rivers including Gounamitz, Kedgwick, Restigouche. Brook trout may be harvested in these rivers as well as Green River and the Saint John River System. Madawaska Maliseet First Nation also has FSC access to lake trout in several New Brunswick lakes (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Madawaska Maliseet First Nation holds commercial-communal licences for rock crab, herring, lobster, mackerel and sea scallops for areas of the Gulf of St. Lawrence. Groundfish may be harvested in NAFO areas of the Gulf of St. Lawrence and southwestern Newfoundland (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.64 Socioeconomic Overview of the Madawaska Maliseet First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Madawaska Maliseet First Nation and other agencies provide community services in education, health care, social services and housing. Identified community issues include diabetes and addictions. • Madawaska Maliseet First Nation economic initiatives include a highway retail centre, smoke shop, gas station, hotel, car dealership, restaurant and casino. • Madawaska Maliseet First Nation is involved in the commercial fishery and has four lobster fishing vessels.	• A general description of the history and culture of the NB Maliseet is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: MMEDC (2017); MMAN (2011)		

7.4.6.3 Oromocto First Nation

Oromocto First Nation is located in the Saint John River Valley near Fredericton and Gagetown. The First Nation has one Reserve: Ormocto 26. Oromocto First Nation is a member of Wolastoqiyik Nation and affiliated with the Wolastoqey Tribal Council (INAC 2016). Oromocto is represented in consultation by the WNNB (INAC 2017).

In October 2017, Oromocto First Nation had a total Registered population of 693. Of the total, about 46 percent are recorded as living on the Reserve (INAC 2017). The population of Oromocto First Nation

showed a small decrease during the latest census period. The First Nation's population is young relative to the New Brunswick population (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Oromocto First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Oromocto First Nation holds FSC fishing licenses to harvest a variety of species (i.e., burbot, catfish, chub, eel, lamprey, muskellunge, white and yellow perch, pickerel, pike, smelt, suckerfish, sunfish, trout, whitefish) in inland and tidal waters of New Brunswick including the Saint John River and lakes in Saint John, Kings, Queens, Sunbury, York, Carleton, Victoria and Madawaska Counties in New Brunswick. Several species (i.e., gaspereau, shad, striped bass, sturgeon) are permitted in tidal waters and another portion of the Saint John River. Oromocto First Nation also holds an FSC licence to harvest lobster in the Bay of Fundy and Atlantic salmon may be harvested in the Saint John River (Newbould, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Oromocto First Nation holds commercial-communal licences for lobster, sea scallops and sea urchins in the Bay of Fundy. Herring may be harvested in coastal areas of Nova Scotia from Cape Breton to the Bay of Fundy. Oromocto First Nation has licences for groundfish in southwestern Nova Scotia and the Gulf of Maine. No area restrictions were identified for gaspereau, bait (herring, mackerel), shad and smelts (O'Neil, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.65 Socioeconomic Overview of the Oromocto First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Oromocto First Nation and other agencies provide services and infrastructure including housing health centre, preschool education and child and family services. Identified issues include addictions.	• A general description of the history and culture of the NB Maliseet is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Oromocto First Nation economic initiatives include commercial fisheries and forestry and a gas station. A local operation has built hand crafted canoes on the Reserve since 1897.		
Sources: First Nation Education Initiative Inc. (Undated); Oromocto First Nation (Undated)		

7.4.6.4 Saint Mary's First Nation

The community of Saint Mary's was documented as an encampment site as early as 1818. The Maliseet people travelled regularly up and down the Saint John River, and it is believed that Maliseet from Kingsclear as well as Madawaska, Tobique, Woodstock and Meductic would have assembled in the area to sell furs and trade handmade goods for supplies. The Saint Mary's Maliseet maintained migratory practices by hunting, fishing and trapping, and traveling downriver each summer. By the mid-1880s, about 25 families lived in 18 dwellings on 2.5 acres at Saint Mary's and for much of the year the families traveled up and down the river camping at various locations, including Oromocto. When the Oromocto was established in 1895, some Maliseet from Saint Mary's relocated to the new Reserve but most remained at Saint Mary's (SMFN Undated).

Saint Mary's First Nation is located in the Saint John River Valley near Fredericton. The First Nation has two reserves: Saint Mary's 24 and Devon 30. Saint Mary's First Nation is a member of Wolastoqey Tribal Council Inc. and represented in consultation by the WNNB (INAC 2017).

In October 2017, Saint Mary's First Nation had a Registered population of 1,917. More than 45 percent of these lived on Reserve land (INAC 2017). The population of Saint Mary's First Nation is young and growing compared to the population of New Brunswick overall (SC 2017). No census data were available for Saint Mary's Reserve.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Saint Mary's First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Saint Mary's First Nation holds FSC fishing licenses to harvest eel, smallmouth bass and trout in inland and tidal waters of New Brunswick including the Saint John River and its tributaries and lakes in Saint John, Kings, Queens, Sunbury, York, Carleton, Victoria and Madawaska Counties in New Brunswick. Fishing for gaspereau, shad and striped bass is permitted in portions of the Saint John River and soft-shell clams may be harvested in tidal waters of Charlotte, Saint John and Albert Counties. Saint Mary's

First Nation also holds groundfish, lobster and scallop licences for the Bay of Fundy. The First Nation has FSC access to Atlantic salmon in the Saint John River (Newbould 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Saint Mary's First Nation holds commercial-communal licences for herring in coastal areas of Nova Scotia from Cape Breton to the Bay of Fundy and lobster, sea scallops and sea urchins in the Bay of Fundy. Northern shrimp may be harvested in NAFO divisions in southwest Nova Scotia and the Gulf of Maine. Swordfish licences are held for NAFO divisions from offshore Newfoundland (including 3L, 3M, 3N, 3O) to the Gulf of Maine. The First Nation also holds commercial-communal licences to harvest gaspereau, shad and bluefin tuna in unspecified areas (Belanger 2017, pers comm; O'Neil 2017, pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.66 Socioeconomic Overview of the Saint Mary's First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Saint Mary's First Nation and other agencies provide services and infrastructure such as a day care, a school, housing, recreation, social services healthcare, clinic, community planning and economic development. Identified health issues include mental health and addictions. • Saint Mary's First Nation economic initiatives include an entertainment centre, supermarket, fish store, gas bar, smoke shop, takeout and restaurant. • Saint Mary's First Nation is also engaged in the fisheries and forestry industries. In 2013, the First Nation owned six active commercial fishing vessels and 20 licences for various species. Most fishing occurs	• The community of St. Mary's was documented as an encampment site as early as 1818. • The Maliseet people travelled regularly up and down the Saint John River, and it is believed that other Maliseet would have also used the site. • A general description of the history and culture of the NB Maliseet is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
within Lobster Fishing Area (LFA) 36 on the Bay of Fundy and the Gulf of St. Lawrence. • Saint Mary's First Nation is not equipped to fish tuna, swordfish or shrimp and these licences are often leased to others for a percentage of the catch.		
Sources: SMFN (Undated); First Nation Education Initiative Inc. (Undated)		

7.4.6.5 Tobique First Nation

Tobique First Nation is located in western New Brunswick near the intersection of the Saint John River and Tobique River. Tobique First Nation has two reserves. The Tobique Reserve was established in 1801 and The Brothers 18 is located on two small islands in Kennebecasis Bay. Tobique First Nation is a is affiliated with Wolastoqiyik Nation and Mawiw Council and represented in consultation by the WNNB (INAC 2017). No census data are available for The Brothers 18.

In October 2017, Tobique First Nation had a Registered population of 2,347. Approximately 63 percent of these individuals lived on Reserve lands (INAC 2017). The population of Tobique First Nation has declined but is still younger than the New Brunswick population in general (SC 2017). No census population data were available for The Brothers 18.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Tobique First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Tobique First Nation has FSC access to smallmouth bass in the tributaries of Tobique River. The First Nation also has FSC access to brook trout in the Saint John River system and Tobique River (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Tobique First Nation holds commercial-communal licences for Jonah crab, lobster and sea urchins in the Bay of Fundy. Sea scallops may be harvested in the Bay of Fundy and in an area on the Atlantic coast of Nova Scotia. Herring may be fished in areas from Cape Breton to the Bay of Fundy. Tobique First Nation has commercial-communal licences for groundfish (unspecified) in NAFO Divisions from

southwest Nova Scotia to the Gulf of Maine. No specific locations were identified for harvesting bluefin tuna, mackerel and ocean quahaugs (O'Neil 2017, pers comm; Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.67 Socioeconomic Overview of the Tobique First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Tobique First Nation and other agencies provide services and infrastructure such as housing, a wellness centre, a school, youth centre • Tobique First Nation economic initiatives include a casino, bingo hall, restaurant, take-out, convenience store, gas station and tobacco shop. • Tobique First Nation holds commercial-communal fishing licences for scallops and lobster, which are fished by a contractor.	• A general description of the history and culture of the NB Maliseet is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Tobique First Nation website (2015); FN (2014); First Nation Education Initiative Inc. (Undated)		

7.4.6.6 Woodstock First Nation

Woodstock Maliseet are the descendants of Indigenous people who have traditionally occupied southwestern New Brunswick along the Saint John River to Kittery Maine, USA (Woodstock First Nation Undated). Woodstock First Nation is located on the Saint John River near the Town of Woodstock. The First Nation is made up of two Reserves (i.e., Woodstock 23 and The Brothers 18). The Brothers 18, which is located on two small islands in Kennebecasis Bay and also affiliated with Kingsclear, Tobique and Madawaska Maliseet First Nations (INAC 2017).

In October 2017, Woodstock First Nation had a Registered population of 1,601. Approximately 27 percent of these individuals lived on Reserve lands (INAC 2017). The population Woodstock First Nation experienced a decline during the most recent census period. Nonetheless, the First Nation's population is younger than that of New Brunswick in general (SC 2017). No census data were available for The Brothers 18.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Woodstock First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Woodstock First Nation holds FSC fishing licenses to harvest species (i.e., eel, smallmouth bass, smelt) within inland and tidal areas in various locations within New Brunswick. in inland and tidal waters of New Brunswick including the Saint John River and its tributaries and lakes in Saint John, Kings, Queens, Sunbury, York, Carleton, Victoria and Madawaska Counties in New Brunswick. Gaspereau, striped bass and trout may be harvested in portions of the Saint John River. Woodstock First Nation also holds FSC licenses for lobster and scallops in the Bay of Fundy. Woodstock First Nation also has FSC access for Atlantic salmon in the Saint John River (Newbould 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Woodstock First Nation holds commercial-communal licences for lobster, sea scallops (also on the Atlantic coast of Nova Scotia) and sea urchins in the Bay of Fundy. There are no location restrictions identified for tuna, herring and bait (herring/mackerel). Woodstock First Nation has licences for swordfish in NAFO Divisions from the Newfoundland offshore (including 3L, 3M, 3N, 3O, 3PS) to the Gulf of Maine and groundfish species from southwest Nova Scotia to the Gulf of Maine (O'Neil 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.68 Socioeconomic Overview of the Woodstock First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Woodstock First Nation and other agencies provide services and infrastructure such as child care, social assistance, preschool, education support, housing, health care and recreation. Identified health issues include mental health, nutrition and additions. • Woodstock First Nation economic initiatives include	• A general description of the history and culture of the NB Maliseet is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of NB. • The Woodstock First Nation community are the descendants of the Maliseet people who have	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
three gas stations/convenience stores and a casino. Woodstock First Nation is also engaged in forestry and commercial fishing for scallops, lobster, sea urchins, swordfish and tuna with four commercial fishing vessels.	traditionally occupied southwestern NB along the St. John River to Kittery Maine, USA.	
Sources: Woodstock First Nation (Undated); First Nation Education Initiative Inc. (Undated)		

7.4.7 Peskotomuhkati Nation (Passamaquoddy) of New Brunswick

Another Indigenous Group in New Brunswick is the Peskotomuhkati Nation (also called Passamaquoddy), who are located in St. Andrews. The homeland of the Peskotomuhkati people is centered on Passamaquoddy Bay along with the drainage area of the Schoodic (St. Croix) River and the Fundy Islands (in Canada and the United States). In 2013, it was estimated that the Schoodic Band numbered 300 residing in New Brunswick, primarily in their traditional territory in the southwest part of the province along the Maine and New Brunswick border. A larger group of Peskotomuhkati live in the State of Maine (RSF Undated).

Evidence indicates that the ancestors of the Peskotomuhkati have inhabited their traditional territory from Machias, Maine to Point Lepreau, New Brunswick for the last 13,000 years. Seasonal journeys within their traditional territory, which extended inland north along the Schoodic River to the Chipputnecook Lakes, involved harvesting various natural resources at different times of the year. In the springtime for about six weeks, a field at Salmon Falls on the Schoodic River was occupied by many Peskotomuhkati people who took advantage of the runs up-river by salmon, eels and alewives. Much of the harvest was processed/dried for the following winter. Passamaquoddy Bay was important for its abundance of pollock. The island of Grand Manan was also an important fishing and hunting location (RSF Undated).

At least three Peskotomuhkati Reserves were established in Charlotte County, New Brunswick in the 19th and early 20th centuries. The Schoodic Reserve, located in present day Milltown, NB, was established in 1785 on land adjacent to the Schoodic Falls, which was an important fishing place and tribal burial ground. The Canoose Reserve, at the confluence of the Canoose and Schoodic Rivers, was created in 1851. The St. Croix Reserve was created in 1881 on the St. Croix River near the outlet to the Chiputneticook Lakes. At least two other tracts of land, located at Qonasqamkuk (St. Andrews) and Grand Manan Island known to be Peskotomuhkati gathering places, were the subject of various petitions for reserve status, were never formalized as reserve lands (RSF Undated).

Following the American Revolution, the Peskotomuhkati homeland became inhabited by British Loyalist settlers who had defended the border against American encroachment. Much of the Reserve land became occupied by settlers while the Peskotomuhkati were absent during seasonal hunting and fishing

migrations. The Peskotomuhkati have made official petitions to the Canadian and United States governments but to date have not been able to regain the Reserve lands. The American Peskotomuhkati are recognized as Indigenous People by the United States Government (RSF Undated). A claim submitted to the Canadian government has currently been accepted for review (INAC 2017).

As discussed, the Passamaquoddy are specifically named in the Marshall Decision based on the Peace and Friendship Treaties, which provides them with a Treaty right to fish.

The following sections describe the health and socioeconomic conditions of the Peskotomuhkati Nation based on publicly available information. For some indicators, little information was available publicly (Table 7.69).

Table 7.69 Socioeconomic Overview of the Peskotomuhkati Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Limited information is available on the health and socioeconomic conditions of the Peskotomuhkati as a group because they do not live on a reserve or in a separate community.	• Limited public information is available on the history and culture of the Peskotomuhkati Nation. • The point of land jutting into Passamaquoddy Bay, which is now occupied by the Town of St. Andrews, NB, was a major meeting place where sacred ceremonies, burial of chiefs and other activities occurred. • Cultural practices and resources are focused on the lands and waters of NB.	• The Peskotomuhkati have inhabited their traditional territory in New Brunswick and Maine for 13,000 years. More than 70 known pre-contact archaeological sites on the Canadian side hold artifacts representing continuous occupancy. Many more sites are believed to be under water.
Sources: RSF (Undated)		

7.4.8 Mi'kmaq First Nations of Prince Edward Island

As described in Section 7.4.4, early European contact with the Mi'kmaq occurred in the 16th and 17th centuries and at that time, the traditional Mi'kmaq territory included the part of the Gaspé Peninsula, most of New Brunswick, and all of Nova Scotia and Prince Edward Island (OAA website 2015). Presently, two Mi'kmaq First Nations are located on Prince Edward Island (Figure 7.88). These First Nations communities are described in further detail in the following sections.

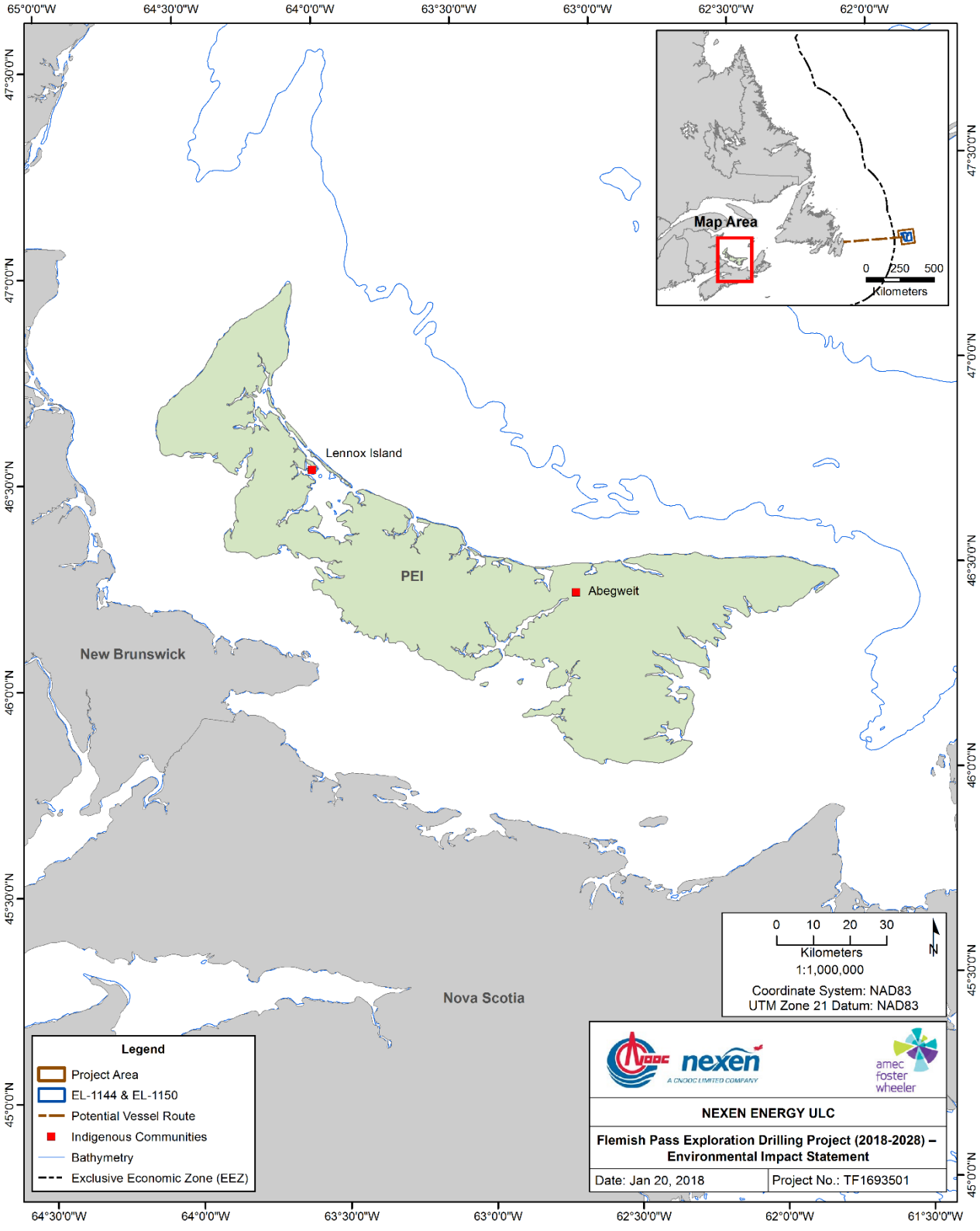
The Mi'kmaq Confederacy of Prince Edward Island (MCPEI) was established in 2002 to deliver programs and services, including Indigenous justice, economic development, integrated resource management and legal/band government advisory services, to Mi'kmaq First Nations in PEI. The organization's mission also includes promoting understanding of Mi'kmaq rights, culture and traditions, developing capacity within First Nation communities, working with other organizations dedicated to supporting the well-being of Mi'kmaq people and providing a common forum to advance Treaty and Aboriginal rights for the Abegweit and Lennox Island First Nations (MCPEI Undated).

The MCPEI began exploratory discussions with Canada and the Province of Prince Edward Island in 2003. In December 2007, the parties signed an agreement to establish a more formal process and to advance the areas of education, health, child and family services, justice and economic development. (Abegweit First Nation 2015; INAC 2017).

The Government of Prince Edward Island's Aboriginal Affairs Secretariat supports work related to the Partnership Agreement with the Mi'kmaq and Canada (PEIAAS Undated). In 2012, the Government of Canada and the Province, and the Mi'kmaq of PEI signed a tripartite consultation agreement, Mi'kmaq – Prince Edward Island – Canada Consultation Agreement. The Agreement outlines a means for Canada and PEI to consult with the Mi'kmaq on proposed actions or decisions that may adversely impact asserted or established Aboriginal or treaty rights (Abegweit First Nation 2015; INAC 2017).

The PEI Mi'kmaq are known to occupy and use the land and waters around PEI including use for travel corridors, hunting, harvesting and fishing for traditional purposes. The discussion of current use of lands and resources for traditional purposes is focused on activities in, and species of interest that may migrate through, the marine environment. The current use of lands and resources section therefore includes a discussion of FSC and commercial-communal fishing.

Figure 7.88 Indigenous Communities in Prince Edward Island



7.4.8.1 Abegweit First Nation

The Abegweit First Nation is located in eastern Prince Edward Island and includes three reserves (INAC 2017). The First Nation was established in 1972 due to a separation from the Lennox Island First Nation. The Abegweit Band retained Morell Reserve 2, Rocky Point Reserve 3 and Scotchfort Reserve 4 while the Lennox Island Band retained Lennox Island Reserve 1 (Abegweit First Nation 2015). Abegweit is governed by one Chief and two Councillors that are elected every four years. Abegweit First Nation is represented by the MCPEI in consultation and engagement (INAC 2017).

As of October 2017, Abegweit First Nation had a Registered population of 379. Approximately 57 percent live on Reserve (INAC 2017). The population of Abegweit First Nation generally shows growth and is younger than the provincial population (SC 2017). Some census data for Morell were suppressed for confidentiality.

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Abegweit First Nation. This discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Abegweit First Nation holds FSC licences for various species (i.e., bar clam, razor clam, soft-shell clam, eel, herring, lobster, mackerel, mussels, oysters, quahaug, scallops, seals, smelt, striped bass, toad crab and rock crab) in tidal areas of Prince Edward Island. Gaspereau, silversides and trout may be fished in tidal and inland waters. Abegweit First Nation hold FSC licences for salmon in the Morell River, West River, Mill River and Trout River (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Abegweit First Nation holds commercial-communal licences for rock crab, spider / toad crab, herring, lobster, mackerel, scallop, snow crab, squid, swordfish and whelk in coastal and inshore areas of Prince Edward Island. Groundfish harvesting is permitted in NAFO 3Pn in southwestern Newfoundland and NAFO divisions in the Gulf of St. Lawrence. There are no location restrictions for clam, eel, American oysters, quahaugs, seal, silversides, tuna, mussel and smelt (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of the Abegweit First Nation, based on existing and available information.

Table 7.70 Socioeconomic Overview of the Abegweit First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Abegweit First Nation and other agencies provide services and infrastructure such as housing, education, early childhood learning, a wellness centre, and employment programs, • Abegweit First Nation owns and operates several businesses including a gas bar, trucking and marine services, commercial fishery and other initiatives in food products, a hatchery, stream enhancement and forestry.	• A general description of the history and culture of the PEI Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of PEI.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Abegweit First Nation (2015)		

7.4.8.2 Lennox Island First Nation

Lennox Island First Nation, established in 1878, is located in the western portion of Prince Edward Island facing the Gulf of St. Lawrence. Lennox Island First Nation consists of one Reserve made up of three parcels of land that occupy all of Lennox Island, which is near Summerside. Lennox Island is represented in consultation and engagement by the MCPEI (INAC 2017).

As of October 2017, the total Registered population of Lennox Island First Nation was 967. About 40 percent lives on Reserve lands (INAC 2017). The population of Lennox Island First Nation lives on Lennox Island 1 Reserve. Like many First Nations communities, Lennox Island has a young and growing population (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

Limited information is available on the current use of lands and resources for traditional purposes by Lennox Island First Nation. The following discussion is based on available information on FSC and commercial-communal fishing harvesting.

FSC Fishing

Lennox Island First Nation holds FSC licences for clams, eel, gaspereau, groundfish, herring, lobster, mackerel, mussels, oysters, quahaug, rock crab, salmon, seals, smelt and trout (Belanger, 2017 pers comm; Statoil 2017).

Commercial-Communal Fishing

Lennox Island First Nation holds commercial-communal licences for rock crab, herring, lobster, mackerel, sea scallop, shark (porbeagle / mackerel), snow crab, squid, swordfish and whelk in inshore areas of the Gulf of St. Lawrence especially in the Northumberland Strait. Groundfish licences are held for inshore areas of NAFO divisions 3Pn (southwest Newfoundland) as well as NAFO areas in the Gulf of St. Lawrence. No location restrictions were identified for clams (unspecified), eel, mussels, quahaug, ocean quahaug, American oysters, seals, silverside, smelt and bluefin tuna (Belanger, 2017 pers comm; Statoil 2017).

Other Socioeconomic Components

Limited socioeconomic information was available for Lennox Island First Nation. Table 7.71 presents an overview based on the available information.

Table 7.71 Socioeconomic Overview of the Lennox Island First Nation

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Lennox Island First Nation and other agencies provide services and infrastructure such as housing, firefighting, education, employment, health care, home support, substance abuse counselling and maternal health care and fitness facilities • Lennox Island First Nation owns a commercial fishery operation. company and a lobster processing facility.	• A general description of the history and culture of the PEI Mi'kmaq is provided in the introduction. • The First Nation's cultural practices and resources are focused on the lands and waters of PEI.	• Although there is limited, published available information, any such resources would be found within the group's traditional territory, far removed from the Project Area.
Sources: Lennox Island First Nation (2013)		

7.4.9 Mi'kmaq First Nations of Québec

The following Québec Mi'kmaq First Nations inhabit the areas on the North Shore of the St. Lawrence River and on the Gaspé Peninsula (Figure 7.89). The following sections present an overview description of these five Mi'kmaq First Nations, including information on the socio-cultural aspects identified in Section 5(1)(c) of CEAA 2012 (namely, current use of lands and resources for traditional purposes, health and socioeconomic conditions, physical and cultural heritage, and any structures, sites or things of historical, archaeological, paleontological or architectural significance). This overview is based on existing and available information, with a variety of sources having been identified, reviewed and used as indicated and referenced throughout.

As previously outlined in Section 7.4.4 above, the traditional territory of the Mi'kmaq people encompasses all or parts of (including coastal and marine waters) the provinces of Nova Scotia, Prince Edward Island, New Brunswick, Québec and Newfoundland and Labrador. Among the districts of the traditional Mi'gma'gi (Mi'kmaq) territory is the Seventh District, Gespe'gewa'gi, which includes north and north-central New Brunswick, the Gaspé Peninsula, parts of the mainland of Québec, as well as the islands and surrounding waters. This District includes the Mi'kmaq First Nations of Gesgapegiag, Gespeg and Listuguj on the Gaspé Peninsula in Eastern Québec (MMS 2017).

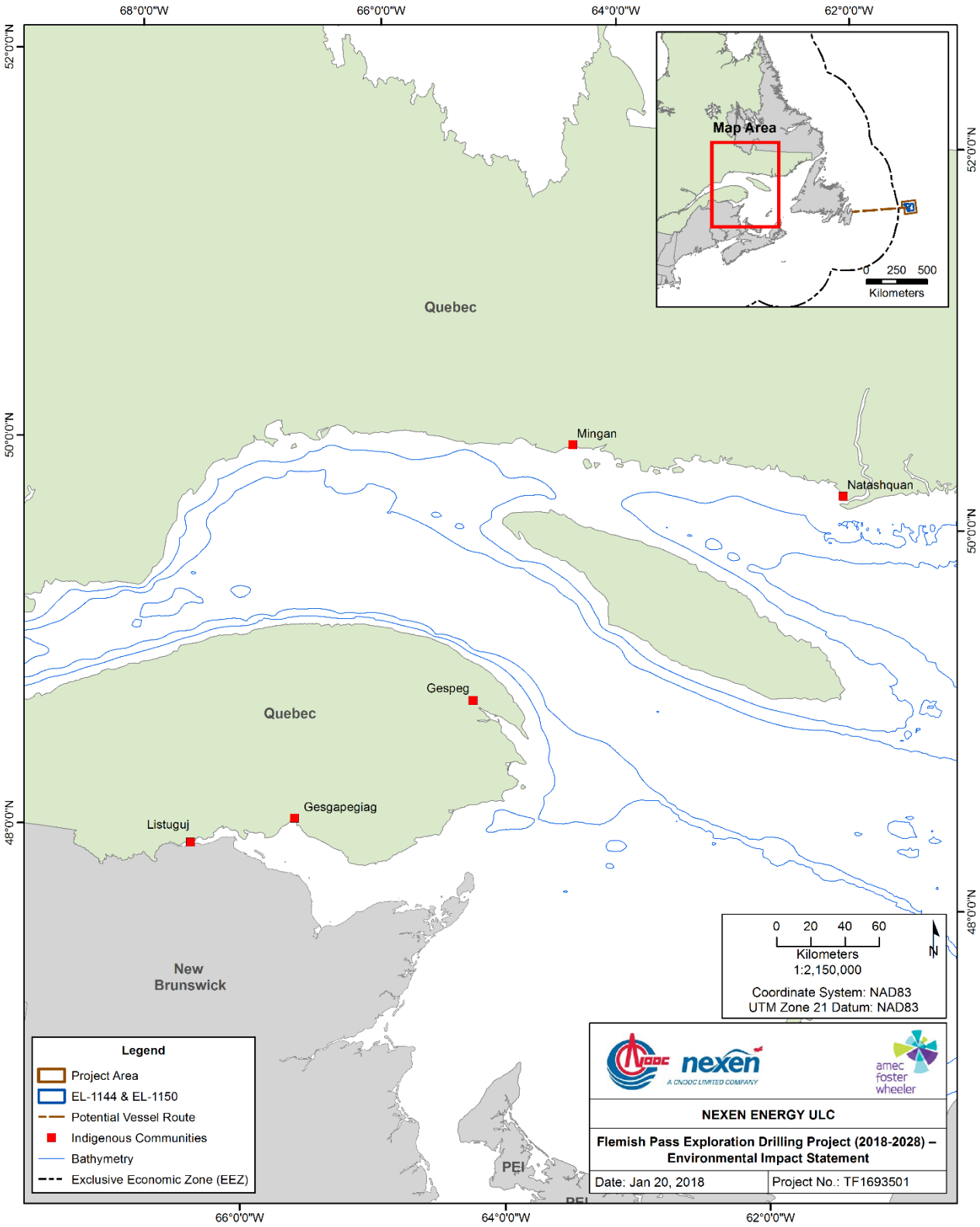
In 1999, the Nation Micmac de Gespeg, which is recognized as a Band with no Reserve lands, signed a tripartite framework agreement with the governments of Canada and Québec for the conduct of self-government negotiations. The three parties amended the framework agreement in 2006 to allow for the continuation of negotiations (SAA 2017). These negotiations ceased in 2014 (INAC 2017).

In 2000, the Mi'kmaq communities of Gespeg, Gesgapegiag and Listuguj formed the Mi'gmawei Mawiomi via a political accord, following which the Mi'gmawei Mawiomi Secretariat was created to represent the Mi'gma'gi of Gespe'gewa'gi (Seventh District or Gesgapegiag) in land claims negotiations with the Governments of Canada and Québec. The Mi'gmawei Mawiomi submitted a statement of claim in 2007. The Mi'kmaq, Québec and Canada formally agreed to pursue land claims negotiations in 2008, and signed a framework agreement and a consultation agreement in 2012. The three parties are currently negotiating an agreement-in-principle (AIP) that should eventually lead to a final land claim agreement (INAC 2014, INAC 2016; MMS 2017).

The primary land claim area includes, but is not limited to, all the territory of Gesgapegiag. It covers the entire Gaspé Peninsula and extends westward along the St. Lawrence River past Rimouski, Québec. It also includes Anticosti Island and an area north and north-east of Edmundston, New Brunswick. A potential "secondary claim" has been identified but is not being pursued at present (MMS 2017).

In 2001, the Conseil de la Nation Listuguj Mi'gmaq signed a framework agreement with the Government of Québec to encourage the conclusion of sectoral agreements in areas of common interest. The Micmacs of Gesgapegiag signed a similar agreement with the Government of Québec in 1999 (SAA 2017).

Figure 7.89 Indigenous Communities in Québec



7.4.9.1 Micmacs of Gesgapegiag

The Gesgapegiag Reserve is located on the south shore of the Gaspé Peninsula, at the intersection of the Gesgapegiag River estuary and the Baie des Chaleurs. The First Nation has one Reserve: Gesgapegiag (INAC 2017).

The First Nation has a registered population of 1,529, of whom approximately 46 percent live on the Gesgapegiag Reserve. The Conseil de bande des Micmacs de Gesgapegiag has a Chief and eight Councillors and is represented by the Mi'gmawei Mawiomi Secretariat in land claims negotiations and consultation/engagement (INAC 2017; MOG 2017). The population of the Gesgapegiag Reserve decreased between 2011 and 2016. Decreases could be a result of a lower birth rate or possibly out-migration as approximately half of the registered population of Gesgapegiag presently live off Reserve. The population of the Reserve is younger than that of the Province of Québec as a whole (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

The Mi'kmaq of Québec are known to occupy and use the land and waters around the Gaspésie including use for travel corridors, land hunting and harvesting and fishing for traditional purposes. The discussion of current use of lands and resources for traditional purposes is focused on activities in the marine environment and species of interest (to Québec Mi'kmaq Indigenous communities) that may migrate through the marine environment. The current use of lands and resources section therefore includes a discussion of FSC and commercial-communal harvesting where this information is available.

The fishing season began in the spring with the break-up of shore and river ice, when the Mi'kmaq moved to coastal areas and river mouths such as the estuaries of the Restigouche and Cascapédia Rivers that flow into the Baie des Chaleurs. Fishing began with shallow water fish species exposed by the melting ice, the most important of which was winter flounder. The next fishing period included spawning runs of fish that were migrating from fresh water to the sea or the reverse. These species included smelt in March, alewife in April and sturgeon in May. Typically, salmon were harvested in May as well as July and August, eel in September and Atlantic tomcod as late as December (CIE 2014).

Fish spawning seasons were accompanied by the spring migration of sea-bird species that nested in the same areas. Eggs were also collected from offshore islands. Sea-bird hunting took place in early fall during the migrations south. During spring and summer, the Mi'kmaq harvested marine shellfish including oysters, scallops, quahogs, clams, American lobster and northern crab. Oysters harvested from the southern Gulf of St. Lawrence were used for food and the shells were used for wampum. During whelping season, the Mi'kmaq also harvested marine mammals such as walrus and seal (CIE 2014).

The rights of the Mi'kmaq to harvest these species were affirmed in treaties with the British Crown beginning as early as 1725. In the contemporary period, the Mi'kmaq people continue to harvest these species and are concerned for the survival of traditionally harvested species. At a workshop about salmon held by the Gespe'gewaq Mi'gmaq Resource Council (a non-profit organization focused on understanding better the aquatic issues that affect its member communities) with Mi'kmaq Elders, many participants expressed concerns about contaminants in the water, declining stocks and the need for management plans to address the threats to salmon habitat. In the case of some species, such as eel,

harvesting by the Mi'kmaq has declined due to pollution in the waters of the Restigouche River and Baie des Chaleurs and Mi'kmaq believed the fish was no longer safe to eat (CIE 2014; GMRC 2015).

The Micmacs de Gesgapegiag traditionally used Atlantic salmon for barter, spiritual or ceremonial practices, bait (salmon skin) and crafts. Salmon fishing methods evolved from harpoons to gill nets and cages for communal fishing and fly-fishing rods for recreational fishing. Fishing occurred from late May to early November. Members of Gesgapegiag have caught salmon in the mouth of the Cascapédia River and upstream, as well as in neighbouring rivers (Petite rivière Cascapédia, Bonaventure, Nouvelle and Hall) (MMAFMA 2017).

The Micmacs de Gesgapegiag participate in communal fishing for FSC purposes. The First Nation also has an agreement with the Government of Québec for communal fishing, which occurs principally in the Cascapédia River mouth but also in the Petite rivière Cascapédia and its mouth (MMAFMA 2017).

Annual subsistence harvests of salmon by the Micmacs de Gesgapegiag in the Cascapédia River were reported for the 1984-2008 period. Gesgapegiag has not taken any salmon in the Cascapédia River since 2009 pursuant to an agreement with the Government of Québec to cease fishing salmon in return for monetary compensation.

Eel harvesting is a traditional Mi'kmaq activity. It begins in May and ends when the ice cover forms. According to members of the Micmacs de Gesgapegiag, eel is mostly taken in the mouth and estuary of the Cascapédia River. Harvesting sites extend along the coast from Carleton to Bonaventure, including the Nouvelle area.

Other species have been used for commercial and/or recreational purposes. Cod fishing has been important to the economic and cultural landscape of the Gaspé Peninsula, but is now restricted because of low cod stocks. Consequently, most cod that is harvested is by-catch in the commercial fishery or through recreational fishing and mainly in summer. Members of Gesgapegiag have reported catching cod in the Cascapédia River estuary in recent years. Commercial and recreational fishers catch cod in the Baie des Chaleurs, all along the coast, between Bonaventure and New Richmond, as well as in the vicinity of Miguasha. Also, it appears that cod is frequently taken in the two snow crab fishing zones, east of the point of the Gaspé Peninsula and south of New Brunswick.

Members of the Micmacs de Gesgapegiag have reported that striped bass is mostly captured as by-catch in the Cascapédia River estuary and along the shoreline near Carleton and New Richmond. Striped bass is generally harvested between May and October and consumed or used as bait to catch smelt. The species is often a by-catch when using gill nets (salmon), spinning rods (trout or mackerel) or fly rods (recreational fishing) (MMAFMA 2017). The marine area of the Banc des Américains is of economic, ecological and cultural importance for the Mi'kmaq communities. The area and its periphery are used to harvest crab, lobster, mackerel, herring, cod and waterfowl. Many members of the Micmacs de Gesgapegiag also travel to the area for whale-watching (MMAFMA 2017).

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.72 Socioeconomic Overview of the Micmacs de Gesgapegiag

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• The Micmacs de Gesgapegiag and other agencies provides services and infrastructure in education, health care, social services, public security (fire and police), public works, economic development (e.g., forestry and commercial fisheries), addictions treatment and employment. • Identified health issues include healing, diabetes, mental health and addictions. • Economic initiatives include commercial fisheries with commercial-communal licences for mackerel, herring and bluefin tuna. Commercial harvesting of groundfish (e.g., Atlantic halibut, Greenland halibut, redfish) is planned. The First Nation is involved in an aquaculture initiative to grow and process kelp products.	• General information on the history of the Mi'kmaq people has been provided in previous sections. • No specific information was available on the physical and cultural heritage of the Micmacs de Gesgapegiag. • In general, the Mi'kmaq lived a semi-nomadic lifestyle moving from place to place throughout their territory to harvest food and resources. • As fishers, hunters and gatherers, the people used their intimate knowledge of the land and seasonal cycles of vegetation, animals and fish to meet their physical and spiritual needs.	• Limited specific information was available on the heritage resources of the Micmacs de Gesgapegiag. • Traditional Mi'kmaq camps are known to have been located on the shores of the St. Lawrence River estuary. • Any heritage resources would likely be found in that area.
Sources: GHCS (2016), MOG (2017), GOC (2017), YSAC (Undated), CDPDJ (2009), MMAFMA (2013), MMNN (2016), Saumon Québec (2017), MFFP (2017a), MGS (2016)		

7.4.9.2 La Nation Micmac de Gespeg

The Nation Micmac de Gespeg has no land base. Its 790 Registered members live throughout the Gaspé Peninsula and in other areas. The Conseil de la Nation Micmac de Gespeg is governed by a Chief and eight Councillors, and is also represented by the Mi'gmawei Mawiomi Secretariat in matters relating to land claims, negotiations and consultation/engagement (INAC 2015; INAC 2017). No census information is available specifically for la Nation Micmac de Gespeg.

Current Use of Lands and Resources for Traditional Purposes

As previously discussed, the Mi'kmaq have traditionally relied upon marine resources. The people of La Nation Micmac de Gespeg traditionally used Atlantic salmon for barter, spiritual or ceremonial

practices, bait (salmon skin) and crafts. Salmon fishing methods evolved from harpoons to gill nets and cages for communal fishing and fly-fishing rods for recreational fishing. Fishing occurred from late May to early November. Members of Gespeg took salmon in the Saint-Jean, Dartmouth, York, and Malbaie Rivers, and in the mouth of the Dartmouth River (MMAFMA 2017).

The Micmac de Gespeg participates in communal fishing for FSC purposes and has an agreement with the Government of Québec for harvesting salmon on the Saint-Jean, Dartmouth and York Rivers. Gill nets are used in June in the river mouths and fishing continues later upstream in river pools using seines, small nets and rods. A total of 258 salmon were captured between 2010 and 2015. Most of the harvested salmon is distributed to Elders. Individual sport fishing by members of Gespeg First Nation yielded a total catch of 110 salmon between 2010 and 2015 (MMAFMA 2017). Eel harvesting sites reported by the Gespeg First Nation include the shoreline between Gaspé and Percé. Incidental by-catches are frequent in Gaspé Bay (MMAFMA 2017).

According to some members of la Nation Micmac de Gespeg, cod is often taken in the Gaspé Bay, in particular at the northern extremity, as well as along the southern part, along the Sandy Beach pier. Other fishing areas identified by the community include Rivière-au-Renard, the Malbaie River estuary, Percé and the Banc des Américains. Cod is captured with jigs as part of recreational fishing. It is sometimes harvested as by-catch with spinning rods, dragnets or gill nets (when fishing for salmon) or lobster traps (MMAFMA 2017).

Members of la Nation Micmac de Gespeg harvest striped bass at locations between Gaspé and the Malbaie River estuary generally between May and October. Eel, which is consumed or used as bait to catch smelt, is often a by-catch when using gill nets (salmon), spinning rods (trout or mackerel) or fly rods for recreational fishing (MMAFMA 2017).

Other Socioeconomic Components

The following table summarizes information on other socioeconomic components related to the Micmac de Gespeg, who do not have a land base. Public information was not available to describe the health and socioeconomic conditions of the Micmac de Gespeg, whose members reside in various communities. Limited information is available on various topics (Table 7.73).

Table 7.73 Socioeconomic Overview of the Micmac de Gespeg

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• La Nation Micmac de Gespeg is involved in commercial fisheries through MMAFMA, which holds commercial-communal licences for fishing mackerel, herring and bluefin tuna.	• General information on the history of the Mi'kmaq people has been provided. • No specific information was available on the physical and cultural heritage of the Micmac de Gespeg. • In general, the Mi'kmaq lived a semi-nomadic	• Limited specific information was available the heritage resources of the Micmac de Gespeg. • Traditional Mi'kmaq camps are known to have been located on the shores of the St. Lawrence River estuary.

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• MMAFMA is planning to be engaged in commercial harvesting of groundfish (e.g., Atlantic halibut, Greenland halibut, redfish) and is involved in an aquaculture initiative to grow and process kelp products.	lifestyle moving from place to place throughout their territory to harvest food and resources. • As fishers, hunters and gatherers, the people used their intimate knowledge of the land and seasonal cycles of the vegetation, animals and fish to meet their physical and spiritual needs.	• Any heritage resources would likely be found in that area.
Sources: MMAFMA (2017)		

7.4.9.3 Listuguj Mi'gmaq Government

The Listuguj Reserve was established in 1853. The Reserve is located at the mouth of the Restigouche River in the southwestern area of the Gaspé Peninsula (INAC 2017).

This Listuguj Mi'gmaq have a registered population of 4,051 of whom just over 50 percent live on the Reserve. The Band Council has a Chief and eight Councillors and is also represented by the Mi'gmawei Mawiomi Secretariat in land claims negotiations and consultation/engagement (INAC 2017). The population of the Listuguj Reserve decreased between 2011 and 2016. Decreases could be a result of a lower birth rate or out-migration because approximately half of the registered population of Listuguj lives off Reserve. During the same census period, the population of Québec grew by 3.3 percent. The population of the Listuguj Reserve is younger than that of the Province of Québec as a whole by approximately five years. The proportion of the Reserve population under 15 years of age in 2016 was higher than that of the Québec population (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

As previously discussed, the Mi’kmaq have traditionally relied upon marine resources. The Listuguj Mi'kmaq participate in communal fishing for FSC purposes with licences to harvest salmon and lobster (Statoil 2017). The Listuguj Mi'gmaq have taken approximately 1,000 salmon annually in the Restigouche River for subsistence since 1984. Eel harvesting is a traditional Mi’kmaq activity that begins in May and ends when the ice cover forms.

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.74 Socioeconomic Overview of the Listuguj Mi'gmaq

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• The principal economic activities of the Québec Mi'kmaq are commercial fisheries, forestry, construction, tourism, handicraft production and outfitting. Listuguj Mi'gmaq is engaged in commercial fisheries and forestry. • The Conseil de la Nation Listuguj Mi'gmaq and other agencies provide facilities and programs in housing, education, community and social services, health, community health, women's shelter, long-term care facility for the elderly, a youth group home, fire safety, policing, restorative justice, drinking water, wastewater management, solid waste management, roads and natural resource management. • Identified health and social issues include chronic illness, mental health and addictions, diabetes, foster care, care of the elderly, physical inactivity and family issues. • The Listugui Mi'gmaq holds commercial-communal fishing licences for snow crab, shrimp, lobster, mussels, turbot and cod. Listuguj Fisheries owns 13 fishing vessels. The Band Council is also involved in forestry.	• General information has been provided on history of the Mi'kmaq people. No specific information was available on the physical and cultural heritage of the Listuguj Mi'gmaq. • In general, the Mi'kmaq lived a semi-nomadic lifestyle moving from place to place throughout their territory to harvest food and resources. • As fishers, hunters and gatherers, the people used their intimate knowledge of the land and seasonal cycles of the vegetation, animals and fish to meet their physical and spiritual needs.	• No specific information was available on the heritage resources of the Listuguj Mi'gmaq. • Traditional camps were located on the shores of the St. Lawrence River estuary. • Any cultural resources (including structures, sites or things of historical, archaeological, paleontological or architectural significance) would likely be found in that area.
Sources: LMG (2016), Listuguj Fisheries (2014), MMAFMA (2013), MFFP (2017a), GOC (2017)		

Summary of Marine Species Harvested by Selected Québec Mi'kmaq Groups

Various sources of information have been used to identify the species, location and timing related to marine resources harvested by selected Québec Mi'kmaq Groups. Table 7.75 summarizes this information.

Table 7.75 Summary of Marine Species Harvested by Selected Québec Mi'kmaq Groups

Resource	Groups	Location(s)	Season
Cod	Gesgapegiag	Baie des Chaleurs, Cascapédia River estuary, coast between Bonaventure and New Richmond, east of Gaspé Peninsula point and south to New Brunswick	NA
	Gespeg	NA	
	Québec Mi'kmaq	Banc des Américains	
Crab	Québec Mi'kmaq	Banc des Américains	NA
Eel	Gesgapegiag	Cascapédia River mouth and estuary, along the coast from Carleton to Bonaventure including Nouvelle area	May to early November
	Gespeg	Gaspé bay, shoreline between Gaspé and Percé	NA
Herring	Québec Mi'kmaq	Banc des Américains	NA
Lobster	Québec Mi'kmaq	Banc des Américains	NA
Mackerel	Québec Mi'kmaq	Banc des Américains	NA
Salmon	Gesgapegiag	Bonaventure River, Cascapédia River mouth and upstream, Hall River, Nouvelle River, Petite rivière Cascapédia and its mouth	May to early November
	Gespeg	Dartmouth River and its mouth, Malbaie River, Saint-Jean River, York River	May to early November
	Listuguj	NA	NA
Striped Bass	Gesgapegiag	Cascapédia River estuary, along the shoreline near Carleton and New Richmond	NA
	Gespeg	Gaspé, Malbaie River estuary	NA
Waterfowl	Québec Mi'kmaq	Banc des Américains	NA
Source: MMAFMA (2017)			

7.4.10 Innu First Nations of Québec

In addition, two Québec Innu First Nations are considered in the EIS, as required by the EIS Guidelines, which are located on the North Shore of the St. Lawrence River (Figure 7.89).

The Innu people were traditionally nomadic and depended on the products of hunting (mainly barren-ground caribou, moose and small game), fishing and gathering activities for their subsistence. Their ancestral territory covers the entire region between Québec City and Labrador and extends north of Schefferville. At the end of the 19th century, participation in the fur trade, settlement and expansion of the forestry and mining industries led to establishment of permanent Innu communities, mainly in the south of their territory. In northern parts of the territory, the process of settlement began in the 20th

century, and in some cases not until after 1950 (CDPDJ 2009). The following sections describe the Innu of Ekuanitshit and Nutashkuan.

Québec Innu land claim negotiations were first initiated in 1979 by the Atikamekw and Montagnais Council, which was established in 1975 to represent nine Québec Innu Nations and three Atikamekw Nations. Due to differences of opinion, mainly with respect to recognition of Indigenous rights and certainty, the Atikamekw and Montagnais Council was later dissolved.

In 2004, the Mamuitun mak Nutashkuan Tribal Council completed negotiations on behalf of the Innu First Nation communities of Essipit, Mashteuiatsh, Nutashkuan and Pessamit and an AIP was signed with the governments of Québec and Canada (Tremblay 2011). The land claims AIP is considered to be significant in that the Innu First Nations would not surrender title over their traditional territory and would no longer be subject to the *Indian Act* (NP 2016). Instead, a form of self-government would be determined. The area over which the Nutashkuan First Nation Tribal Council claims ancestral rights includes the waters between the shoreline on which the community located and Anticosti Island; it also covers part of Anticosti Island (RP 2017).

In 2005, Pessamit First Nation ceased to participate in the negotiations and adopted a litigation approach. The Mamuitun mak Nutashkuan Tribal Council continued to represent the other three First Nations, including the Montagnais de Natashquan (RP 2017). In 2010, the Mamuitun mak Nutashkuan Tribal Council was renamed the Regroupement Petapan Inc. and negotiations towards a final agreement are still underway (INAC 2016).

The Regroupement Mamit Innuat Tribal Council (MICT) was formed in 1982 as an advisory body to create a common development structure for the four "Montagnais" Innu First Nations of the Lower North Shore (i.e., Ekuanitshit, Nutashkuan, Unamen Shipu and Pakua Shipu). The MICT represents the interests of the First Nations in public, provincial, national and international initiatives (MICT 2011). In 1994, the Mamu Pakatatau Mamit Assembly was created to represent the Innu communities of Ekuanitshit, Unamen Shipu and Pakua Shipi in land claims negotiations, which took place from 1995 to 2007 with Canada and Québec. In 2008, however, the three member communities ceased the negotiation process in favour of a litigation approach (INAC 2016).

7.4.10.1 Innu de Ekuanitshit

The Mingan Reserve is located at the confluence of the Mingan River and the Gulf of St. Lawrence. The Mingan Reserve faces the Mingan Archipelago, an area used by the Innu for seal hunting and other activities. The Mingan Reserve was established in 1963 for the Innu de Ekuanitshit and settled mainly by Innu families who traditionally travelled the Magpie, Saint-Jean and Romaine Rivers (MRCN 2010; INAC 2017).

The Registered First Nation population of the Conseil des Innu de Ekuanitshit is 645 of whom 94 percent live on the Mingan Reserve. The Reserve is governed by a Band Council with a Chief and four Councillors. The Conseil des Innus de Ekuanitshit is represented by Regroupement Mamit Innuat Tribal Council (INAC 2017). The population of the Mingan Reserve has increased. The median age of the population is at least 10 years younger than the median age of the Québec population. The percentages of population under 15 years of age is also higher than that of the general Québec population (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

As discussed previously, the nomadic Innu culture and heritage is based on the relationship with game and fish and the seasonal migrations and locations of various species, particularly caribou and salmon. The Innu people travelled all over a vast territory encompassing the entire St. Lawrence catchment area between the Saguenay-Lac-Saint-Jean and Labrador. Families also occasionally crossed the St. Lawrence Estuary to hunt in the Bas-du-Fleuve area (MRCN 2010; Verreault et al 2013).

The Innu traditionally spent the winter months in the interior of the Labrador plateau pursuing caribou herds or fishing on the lakes of the Québec-Labrador Peninsula. When caribou were scarce, they hunted small game such as partridge, porcupine or hare. The Innu people would return to coastal areas of the St. Lawrence River in spring to coincide with migrations of important species. In May, thousands of Canada geese landed on shores and lakes during their migration towards the Canadian Arctic. When migratory ducks returned to the north shore of the St. Lawrence in large numbers each May, Innu camps could be found all over the Mingan Archipelago for the purposes of hunting ducks for food and gathering down. In this location, Innu also accessed the upstream migration of Atlantic salmon in June. Summer camps, which were mostly at the mouths of the large Côte-Nord rivers that flow into the estuary and the Gulf of St. Lawrence, were important for social and cultural reasons and sometimes housed hundreds of individuals. In the fall, bands of families left their summer camps beginning the long journey up the larger rivers (MRCN 2010).

Traditional summer activities on the shore of the St. Lawrence included fishing in the mouth of tributary rivers and hunting marine mammals and waterfowl in coastal areas, including the islands in the estuary and the Gulf of St. Lawrence. Fishing has played an important role in the Innu's activities generally, especially those who used the North Shore salmon rivers, including the Moisie, Romaine, St. Augustin, Mingan, Manitou and Natashquan Rivers. Each family generally had their own traditional fishing sites and the catch was shared with family members and friends and sometimes traded for supplies. Smoked salmon also provided food for the journey to the winter hunting grounds (Charest et al 2012; Verreault et al 2013; CIE 2014).

The Innu continue to use the resources of the St. Lawrence for food and communal purposes. Activities include fishing for Atlantic salmon, herring and brook trout; collecting goose eggs in the peat bogs between the River and its tributaries; collecting eggs of other bird species on the islands; hunting waterfowl (e.g., goose and black guillemot); gathering edible plants (e.g., black crowberry and small cranberries) that grow along the River banks and in the peat bogs; fishing for lobster and scallops with harpoons; and collecting other shellfish along the coast (AMIK 2016a; CIE 2014).

The following paragraphs describe contemporary land use of the Innu de Ekuanitshit. The information provided is mainly based on a 1983 study by the Conseil des Atikamekws et des Montagnais (CAM). The report, called the "Étude sur l'occupation et l'utilisation du territoire par les Montagnais de Saint-Augustin", documents land and resource of the Innu communities of Québec and Labrador from 1951 to 1982 (CAM 1983). Information from Hydro-Québec Production's environmental impact study for the Complexe de la Romaine Project (HQP 2007) was also accessed. Additional sources of information are a publication (Charest et al 2012) on Indigenous fisheries in eastern Québec and an overview of salmon fishing in Québec in 2016 (MFFP 2017a).

Various records show that the traditional travel routes of the Innu de Ekuanitshit covered a large territory. In the second half of the 19th century, the connections between the Innu de Ekuanitshit and those of Central Labrador were especially strong, with frequent long-distance travel between the two areas most notably during the time when the Hudson's Bay Company (HBC) operated trading posts in the region. Historically, the Innu of Ekuanitshit would leave the community in August or September and travel towards the interior of Labrador, returning to the south again in the spring (CAM 1983).

Records of the contemporary period (1951 to 1982) show that the locations of camp sites were concentrated south of the Labrador-Québec border near the community itself and along the coast of the St. Lawrence River, at the mouths of inflowing rivers, and contemporary travel routes sometimes extended more than 100 km into Labrador during this period. The Romaine River basin was used for hunting (including for migratory birds), trapping, salmon fishing and community or family reunions (CAM 1983; HQP 2007). Due to their greater accessibility, the basins of the Puyjalon, Bat-Le-Diable, Allard and Au Foin Rivers in the southern portion of the area are frequently used by the Innu de Ekuanitshit. In addition, the Innu de Ekuanitshit use the shoreline intensely and own at least 16 hunting chalets located on the coast where hunters of migratory birds and small game (particularly porcupine) gather (HQP 2007).

During the fall, trapping was prevalent and hunting was focused on porcupine, hare and caribou (Table 7.76). Though trapping continued as winter progressed, subsistence hunting for caribou and small game became of greater importance. From mid-February to the end of April, beaver trapping was a focus, particularly when men traveled without their families, though women and children often joined the hunters on weekends if the camp was near the Mingan Reserve. In the spring, as the rivers became ice-free, beaver, otter and muskrat were trapped and subsistence activities shifted to migratory bird hunting, which continued from spring through summer. Salmon fishing began towards the end of May and continued to be a common activity throughout the summer. Summer was a time of gathering with Innu from other communities and included festivals and the annual pilgrimage to Sainte-Anne-de-Beaupré in August (CAM 1983).

Table 7.76 Species Harvested by the Innu de Ekuanitshit (1951-1982)

Resource	Journey North	Fall	Winter	Winter/Spring	Spring
Mammals					
Porcupine	●	●	●	●	●
Caribou	●	●	●	●	●
Beaver	●	●	●	●	●
Hare	●	●	●	●	●
Otter	●	●	●	●	●
Mink		●	●	●	
Muskrat	●	●	●		●
Fox		●	●		●
Moose		●	●		●
Weasel		●	●		●
Lynx		●	●		●
Marten		●		●	●
Wolf			●	●	
Marmot					●
Bear					●

Resource	Journey North	Fall	Winter	Winter/Spring	Spring
Squirrel		●			
Seal					●
Birds					
Partridge	●	●	●	●	●
Duck	●	●		●	●
Goose	●	●		●	●
Willow ptarmigan		●	●		
Merganser	●				●
Loon					●
Bird's eggs					●
Fish					
Trout	●	●	●	●	●
Pike	●	●			●
Carp	●	●			●
Lake trout	●	●		●	
Ouananiche		●	●		●
Whitefish		●			●
Salmon	●				
Burbot		●			
Source: CAM (1983)					

On the Romaine River, immediately downstream of Grande Chute, hunting is practiced by the Innu de Ekuanitshit in a long corridor using motorized canoe and snowmobile. Trapping focuses on beaver and certain other furbearers (e.g., otter, muskrat). Canada geese, small game and salmon are also harvested. Various species of ducks are hunted, particularly in the Grande Hermine Bay, west of Baie-Johan-Beetz, and in the mouths of the Romaine and Mingan Rivers (HQP 2007).

As previously stated, fishing, particularly for Atlantic salmon, traditionally played and continues to play an important role in Innu life on the North Shore of the St. Lawrence River and estuary. The Innu de Ekuanitshit have identified 35 harvesting areas and 21 camps for salmon fishing along the Romaine River and its main tributary, the Puyjalon River. They also take salmon in the Jupitagon, Magpie, Saint-Jean, Mingan and Manitou Rivers (HQP 2007). Harpoons and fishing rods are used to take salmon in the Manitou River, while nets were used in the Romaine River (Charest et al 2012). Salmon fishing (subsistence and sport) in the Romaine River is now closed because of the scarcity of the population (MFFP 2017b).

In the 1970s, the Innu de Ekuanitshit mobilized to regain control of salmon fishing in the Mingan and Manitou Rivers, which had been lost to non-native sport fishing. As a result, they became the managers of those rivers in the early 1980s. In summer 1984, the Innu de Ekuanitshit mandated biologists to study the salmon population in both rivers. As the studies revealed the precarity of the population, the Innu decided to prohibit fishing in those rivers, including for subsistence purposes, for a five-year period. They resumed subsistence salmon fishing in the summer of 1989 in the Mingan and Manitou Rivers, and began to experiment with sport fishing in the Mingan River. In 1992, the Innu de Ekuanitshit created the Société de gestion des rivières Manitou et Mingan (SGRMM) for the management of subsistence and sport salmon fishing. The SGRMM is governed by a board of directors (composed principally of Elders) that provides recommendations to the Band Council. In the past, the Conseil des Innu de

Ekuanitshit fixed a global yearly quota of 160 salmon for both rivers (subsistence and sport fishing combined). The SGRMM also proposes monitoring programs; for example, salmon-counting fences were installed on the Mingan River to monitor the restoration of the population. In summer 2001, the SGRMM employed 17 Innu (Charest et al 2012). No subsistence salmon fishing has been reported for the Mingan River since 2001. The fishing policy for the Innu de Ekuanitshit now permits taking salmon in the Mingan River only through the community's outfitting services, and netting for subsistence purposes is not foreseen. Nonetheless, it appears that some community members fish through the outfitter and that their captures are integrated into the outfitter's data. It also appears that the community organizes a traditional salmon fishing activity, using harpoons, at the end of the outfitting season (MFFP 2017a, 2017c).

The salmon fishing management measures enacted by the Conseil des Innu de Ekuanitshit for the Romaine River, the Puyjalon River (one of the Romaine's main tributaries) and the tributaries of both rivers included the following: each Innu fisher is allowed to use one fly rod, one harpoon and two gill nets (each no longer than 75 feet); the quota is 10 salmon per day for the entire fishing season (Charest et al 2012). Annual subsistence salmon harvests in the Romaine River (mainly associated with the Innu de Ekuanitshit, although Nutashkuan Innu also use the River) were estimated for the 1999-2010 period; the annual catches were 325 for 1999 and 2000, 50 from 2001 and 2009 and 45 in 2010 (MFFP 2017 a, 2017b).

Salmon fishing appears to be more valued by the Innu de Ekuanitshit for social and cultural reasons than economic ones, although the latter should not be under-estimated because salmon remains an important source of high-quality food (HQP 2007). A 2013 study of fishing and community management of salmon by the Innu of Ekuanitshit concluded that, for those who took part, the most important values were sharing and respect, shown through conservation and avoiding waste (CIE 2014).

The records of land and resource use by the Innu de Ekuanitshit show that activities have occurred between the Mingan Reserve area along the coast of the St. Lawrence River and northward to Central Labrador, although in the contemporary period, activities have tended to occur closer to the community. The available records indicate that travel routes, camp sites or land and resources use activities have not occurred within or near the Project Area.

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.77 Socioeconomic Overview of the Innu de Ekuanitshit

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• Conseil des Innu de Ekuanitshit and other agencies deliver social development, finance and administration, patient	• General information on the history and culture of the Innu of Québec has been provided above.	• Limited information is available on the heritage resources of the Innu de Ekuanitshit. • Two important Innu sites have been identified, in the valley of

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
services, social services, technical services, advisory services and health care. • Identified health issues include type 2 diabetes. • The economy is based on arts and handicrafts, fishing, outfitting (fishing for salmon, ouananiche and brook trout), tourism, trapping and service businesses. • Economic initiatives of the Innu de Ekuanitshit include commercial fishing for scallops, crab, halibut, sea cucumber and whelk using six boats.	• Limited information is available for the Innu de Ekuanitshit. • The nomadic Innu culture and heritage is based on the relationship with game and fish and the seasonal migrations and locations of various species, particularly caribou and salmon. • The Innu people travelled all over a vast territory encompassing the entire St. Lawrence catchment area between the Saguenay-Lac-Saint-Jean and Labrador. • Families also occasionally crossed the St. Lawrence Estuary to hunt in the Bas-du-Fleuve area.	the Sainte-Marguerite River on the Gulf of St. Lawrence.
Sources: MICT (2011), OIIQ (2004), HQP (2007), AMIK (2016b, 2016c); Charest et al (2012), MRCN (2010)		

7.4.10.2 Montagnais de Natashquan

The Nutashkuan Reserve, which was established in 1952, is located at the mouth of the Natashquan River in the Gulf of St. Lawrence. Nutashkuan First Nation had a Registered population of 1,144 in October 2017 and approximately 91 percent of the population lives on the Reserve. Nutashkuan First Nation is governed by the Conseil des Montagnais de Natashquan with a Chief and four Councillors. The Band Council is also represented by Regroupement Mamit Innuat Tribal Council (INAC 2017).

The population of the Nutashkuan Reserve had a slight decline in the 2016 census. The median age of the population of the Reserve is at least 10 years younger than the median age of the Québec population. The percentage of population under 15 years of age is also higher than that of the general Québec population (SC 2017).

Current Use of Lands and Resources for Traditional Purposes

The following paragraphs describe contemporary land use of the Montagnais de Natashquan. The information provided is also based on the 1983 CAM study, a 2007 Hydro-Québec Production study, a 2012 publication on Indigenous fisheries and a 2016 study of salmon fishing in Québec.

The Montagnais de Natashquan are also traditionally nomadic and have an ancestral history of travelling as far north as Central Labrador. Contemporary land use activities are based on a long history and tradition of nomadic hunting, fishing, travel, gathering and use of encampments over a large

territory. During the contemporary period (1951-1982), harvesting activities were seasonal throughout the year, but women and children were more likely to remain in the community during the winter months (CAM 1983).

Harvesting activities in the contemporary period included catching a variety of mammals, birds and fish (Table 7.78). During the northern overland journey in late summer, the Montagnais de Natashquan harvested small game and fish and established caches for the return trip. The winter hunt focused on caribou, moose and hare at camps generally located within 65 km of the community. In late winter the Montagnais returned nearer to the Reserve from where they trapped, mainly by snowmobile. In spring, when the rivers became ice free and the spring migration occurred, harvesting activities included hunting birds and collecting eggs near the Reserve. Hunting waterfowl, picking berries and collecting plants were important activities during the summer months. Fishing activities were most common during spring and summer. Trout fishing occurred in spring, mainly within a day's travel of the community by snowmobile. In late spring, once the rivers were ice-free, fishing for salmon and sea trout dominated harvesting efforts (CAM 1983).

Table 7.78 Species Harvested by the Montagnais de Natashquan (1951-1982)

Resource	Journey North	Fall	Journey South	Winter	Winter/Spring	Spring	Summer
Mammals							
Porcupine	●	●	●	●		●	
Caribou	●	●	●	●		●	
Beaver	●	●	●		●	●	
Hare		●	●	●	●		
Mink		●	●		●	●	
Muskrat	●	●			●	●	
Bear	●	●				●	
Otter		●	●			●	
Bobcat		●	●		●		
Fox		●	●		●		
Squirrel		●			●		
Marten		●			●		
Wolf		●					
Ermine		●					
Deer					●		
Marmot					●		
Canadian lynx					●		
Weasel					●		
Birds							
Partridge	●	●	●	●	●		
Willow ptarmigan	●	●	●	●	●		
Merganser	●	●			●	●	●
Duck	●	●			●	●	●
Goose	●	●			●	●	●
Loon		●			●	●	●
Owl		●			●		

Resource	Journey North	Fall	Journey South	Winter	Winter/Spring	Spring	Summer
Bird's eggs					●	●	
Fish							
Trout	●	●	●	●	●	●	
Salmon	●				●	●	●
Lake trout	●	●	●		●		
Burbot	●	●			●	●	
Sucker	●					●	
Whitefish	●	●					
Pike	●						
Sea trout					●		
Ouananiche					●		
Source: CAM 1983							

The waterways contemporarily used by the Montagnais de Natashquan include the Natashquan, Romaine, De la Corneille, Piashti, Quetachou, Nabisipi and Aguanish Rivers. The southern portion of the land use area extends from the coast to Wakeham, Forgues, Pauline and Métivier Lakes. Trapping and small game hunting in that area is facilitated by good transportation routes (Route 138 and many snowmobile trails) and fairly even terrain. Along the shore, west of Baie-Johan-Beetz, harvesting activities occur up to the Havre-Saint-Pierre region. Lobster and scallops are taken from Nickerson Bay. Canada geese and eider are hunted from the shoreline or by motorized boat, and waterfowl are hunted along the shore. Many hunting areas and encampments are located at the Grande Hermine and Nickerson Bays, as well as on the coastal plain of the Romaine River, particularly on either side of Route 138. Beaver trapping and gathering of small fruit occur on the Romaine coastal plain. Porcupine is often hunted near the shore along Route 138 and other roads leading north. The contemporary land use model of the Montagnais de Natashquan is similar to that of the Innu de Ekuanitshit. In effect, members from both communities at times harvest together or relay one another (HQP 2007).

The Montagnais de Natashquan signed an agreement with the Government of Québec in 1984 to manage subsistence salmon fishing in the Natashquan River. The agreement was revised in 1999 to expand its scope to the management of salmon fishing outfitting services. The Montagnais thus have exclusive rights on a portion of the Natashquan River for subsistence and sport salmon fishing. Nets are allowed for subsistence fishing (one net per house), while only rods are allowed for sport fishing. The reported catches for subsistence purposes fall below the established yearly maximum of 15,000 pounds (Charest et al 2012). Annual subsistence salmon harvests in the Natashquan River have been reported since 1984, with a few exceptions; they range from 350 to 1,479 salmon (MFFP 2017a, 2017 b).

Fishing activity occurs mostly in the first kilometres of the Natashquan River. According to government officials and academics, the health of the salmon population in the Natashquan River is of concern. The Montagnais de Natashquan have a more nuanced view in this matter. The Natashquan River valley is a proposed biodiversity reserve for which a conservation plan is in place (Charest et al 2012).

The Montagnais de Natashquan have continued to be mobile and still cover a large territory but travels are not as expansive as they have been historically. During the contemporary period, the Montagnais have practiced their traditional activities in the southern portion of the territory closer to the Reserve and

along the coast of the St. Lawrence River and at the mouths of other rivers that drain into it (CAM 1983). Thus, their activities do not occur within or near the Project Area.

Other Socioeconomic Components

The following table summarizes some of the key socioeconomic characteristics of this First Nation, based on existing and available information.

Table 7.79 Socioeconomic Overview of the Montagnais de Natashquan

Health and Socioeconomic Conditions	Physical and Cultural Heritage	Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance
• The Conseil des Montagnais de Natashquan and other agencies provide education, medical care, fire protection, policing, social development, finance and administration, patient services, social services, technical services and advisory services. • Identified health issues include type 2 diabetes, obesity and addictions. • The economy of Nutashkuan Reserve is mainly based on arts and handicraft production, trapping, tourism, construction, transportation, outfitting and commercial fishing. • The Conseil des Montagnais de Natashquan owns two fishing vessels and holds commercial fishing licences for crab, clams, lobster and groundfish.	• General information on the history and culture of the Innu of Québec has been provided. • Limited information is available on the history and culture of the Montagnais de Natashquan. • The nomadic Innu culture and heritage is based on the relationship with game and fish and the seasonal migrations and locations of various species, particularly caribou and salmon. • The Innu people travelled all over a vast territory encompassing the entire St. Lawrence catchment area between the Saguenay-Lac-Saint-Jean and Labrador. • Families also occasionally crossed the St. Lawrence Estuary to hunt in the Bas-du-Fleuve area.	• No specific information was available for the Montagnais de Natashquan. • Two important Innu sites have been identified, in the valley of the Sainte-Marguerite River on the Gulf of St. Lawrence.
Sources: MICT (2011), Statistics Canada (2015), MRCN (2010), QAT (2017), AMIK (2016b, 2016c); Charest et al (2012), MFFP (2017a), FNQLEDC (2010), OIIQ (2004), HQP (2007)		

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8 MARINE FISH AND FISH HABITAT: ENVIRONMENTAL EFFECTS ASSESSMENT

Marine fish and their habitats are important considerations in the environmental assessment of any proposed activities that occur within, and that may affect, the marine environment. As described in Section 6.1 the Project Area and its surrounding marine environments are known to be used by a diversity of marine biota. The presence, abundance and distribution of fish species and associated habitat characteristics (both abiotic and biotic) vary considerably across this rather large and diverse marine environment, which transitions from relatively shallow shelf zones (approximately 250 m), through the continental slope to deep areas (up to approximately 1,300 m) (see earlier Figure 6.1). All these areas are used by fish and invertebrate species of commercial, cultural and/or ecological importance and support regionally important areas of biodiversity and marine productivity.

Fish and fish habitat, and the potential effects of the Project on this VC, are subject to the relevant provisions of the federal *Fisheries Act* and its associated regulations, which provides protection to commercial, recreational, and Aboriginal fisheries by protecting the fish resources and habitats that support these activities. Under the *Fisheries Act*, "fish" include all parts and life stages of fish, shellfish, crustaceans and marine animals. Fish habitats include areas that fish directly or indirectly use to live, including nursery, rearing, spawning, migration and foraging areas. Certain fish species and their habitats may also be provided with legislative protection within Canadian (federal *Species at Risk Act*; SARA) and/or provincial (NL *Endangered Species Act*; NL ESA) jurisdictions or have been identified as species of conservation concern through the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

For the purpose of this EIS, this VC includes consideration of relevant fish species (both stable and at risk), as well as plankton, algae, marine plants, benthos and relevant components of their habitats (such as water and sediment), given the clear interrelationships between these environmental components. The consideration of all such components within a single VC is in keeping with current and standard EA practice, and provides for a more comprehensive, holistic assessment approach while at the same time reducing unnecessary repetition. Although any identified fish species at risk are considered integrally within the environmental effects assessment for this VC, these species are given special attention and emphasis herein in the identification, analysis and evaluation of potential environmental effects and any required mitigation measures.

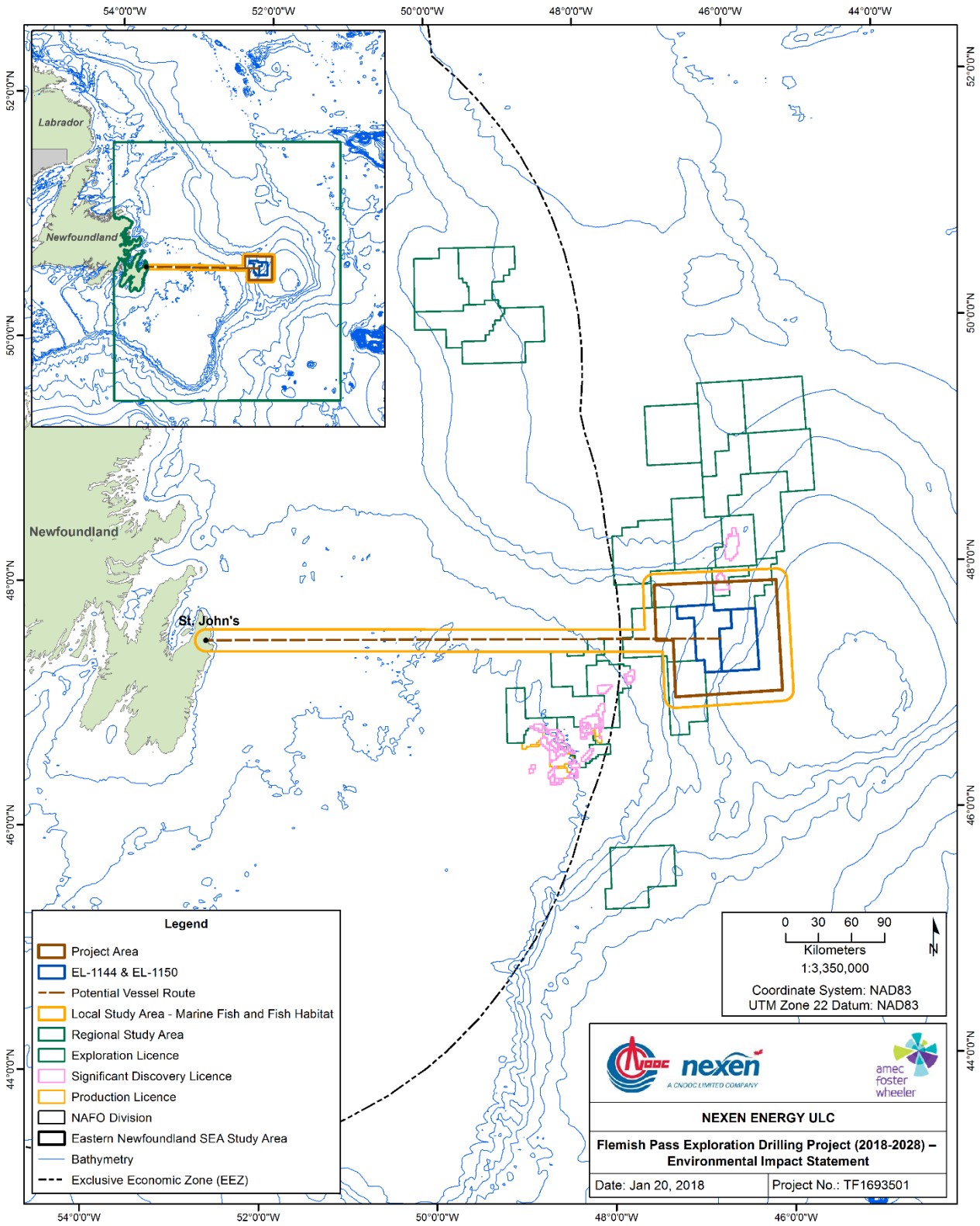
8.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for this VC, as well as the environmental effects evaluation criteria that are used to define and determine the significance of the Project's predicted environmental effects.

8.1.1 Spatial Boundaries

A number of spatial assessment boundaries have been defined for the environmental effects assessment of this VC, which reflect the varying ways and scales in which the Project may influence marine fish and their habitats (Figure 8.1).

Figure 8.1 Marine Fish and Fish Habitat: Environmental Assessment Study Areas



Project Area: This area encompasses the overall geographic area offshore Eastern Newfoundland within which all planned Project-related exploration activities will take place. This includes ELs 1144 and 1150, within which drilling will occur, as well as a surrounding 20 km buffer area to account for any ancillary activities (such as walk away VSP surveys) that may extend outside the boundaries of the ELs themselves. While the Project Area is defined as an overall polygon that encompasses all such activities over the course of the Project, the various activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's components and activities, and therefore, encompasses the overall geographic area over which all planned Project-related environmental interactions (including any emissions and other disturbances) are predicted to occur. As described in this chapter, the main Project-related environmental emissions and interactions that may affect marine fish and fish habitat include the discharge and deposition of drill wastes (cuttings and fluids) and other potential environmental emissions during planned activities, as well as associated underwater noise or other disturbances. These will likely be confined to within several kilometers of the source and the immediate vicinity of the associated vessel and aircraft traffic routes to the ELs. For this VC, the LSA is therefore (conservatively) defined as the Project Area and the associated vessel and aircraft traffic route, and a 10 km area around these.

Regional Study Area (RSA): In addition to Project- and disturbance-related factors, from an ecological perspective the environmental effects assessment also recognizes and considers the particular characteristics and distributions of the individual VCs under consideration, including the larger regional areas and geographic and environmental contexts within which they occur and function. Ecological boundaries for marine biota vary between species, due to difference in their ranges, habitat preferences, movement patterns and key activities. The EA assesses potential effects to fish (individuals and populations) which are known or likely to use the LSA, and considers the overall extent of any affected individuals and populations during the time period at which they may be affected by planned Project activities. Key aspects of marine biota movements and distributions as they relate to the Project Area / LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this Chapter) and cumulative (Chapter 15) effects upon this VC. The overall RSA for the environmental effects assessment is as defined and illustrated earlier in Section 4.3

8.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the potential duration of Project-related activities in the Project Area (2018-2028, see Section 2.7), as well as the likely timing of any resulting environmental effects. In conducting the assessment, special consideration is also given to timing of VC presence within the Project and Assessment Areas, including any particularly important or sensitive periods.

8.1.3 Environmental Effect Significance Definitions

It is within the above described spatial and temporal boundaries that the potential environmental effects on this VC resulting from planned Project components and activities and their significance are assessed and evaluated.

Significant environmental effects are considered to be those that could cause a change in a VC within these spatial and temporal boundaries that would alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this EA, significant environmental effects on marine fish and fish habitat are defined as those that would cause one or more of the following:

- *A detectable decline in overall fish abundance or change in the spatial and temporal distributions of fish populations within the overall RSA over multiple generations.*

- *An unapproved alteration or destruction of fish habitat which results in serious harm to fish resources that support a commercial, recreational, or Indigenous fishery in the RSA*

- *Effects to a designated (protected) species at risk such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected*

The possible environmental effects of accidental events on marine fish and fish habitat are assessed and evaluated in Chapter 16 (Accidental Events).

8.2 Potential Environmental Changes, Effects and Associated Parameters

The key potential environmental interactions between planned offshore oil and gas exploration activities and marine fish and their habitats – including the associated environmental changes and possible resulting environmental effects on this VC – include the following (as summarized and adapted from Amec 2014):

- The possible destruction, contamination or other alteration of marine habitats and benthic organisms due to the discharge and deposition of drill cuttings and/or fluids, the deployment and use of other Project equipment, and possibly the introduction and spread of aquatic invasive species.

- Potential contamination of fish/invertebrates and their habitats due to other environmental discharges during planned oil and gas exploration drilling and other associated survey and support activities.

- The attraction of marine fish to MODUs and vessels, resulting in enhanced potential for injury, mortality, contamination or other interactions.

- Possible injury, mortality or other disturbances to marine fish and invertebrates as a result of exposure to noise within the water column during vertical seismic profiling (VSP) activity.

- The temporary avoidance of areas by mobile marine fish species due to underwater noise or other disturbances, which may alter their overall presence and abundance as well as disturbing movements/migration, feeding or other activities and life stages.

- Possible changes in the availability, distribution or quality of feed sources and/or habitats for fish and invertebrates as a result of planned activities and their associated environmental emissions.

The EIS Guidelines identify and specify a number of issues and potential effects on this VC which require consideration in the EIS (see Part 2, Sections 6.3.1, 6.3.2, 6.3.6). These are listed in detail in the Table of Concordance included at the beginning of the EIS.

A number of questions and comments related to this VC were also noted during Nexen's Project-related consultations with government departments and agencies, stakeholder organizations and Indigenous groups. These include questions and concerns regarding: the potential effects of planned Project activities on key species that are harvested for commercial and/or traditional use purposes, including Atlantic salmon, swordfish, and American eel which may occur in or migrate through the Project Area. (see Chapter 3 for further details).

The environmental effects assessment for this VC considers and focuses upon the various issues and questions identified through these issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result. These are summarized in Table 8.1, along with the identification of a number of associated "parameters" through which any such Project-related changes and effects may be reflected.

Table 8.1 Potential Project-Related Environmental Changes and Resulting Effects: Marine Fish and Fish Habitat

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• Project-related components, activities and any associated emissions or disturbances (drill cuttings, others) may change the physical and/or chemical characteristics of habitats used by marine fish (including invertebrates). • Any resulting environmental changes in the availability, extent and quality of habitats have the potential to affect the presence, abundance and health of fish that use the affected areas.	*Change in Habitat Availability and Quality*	• Amount and quality of key habitat types present in the LSA, relative to their availability within the RSA. • Fish distribution and use of key habitats.
• Changes to the availability, quantity and quality of food sources (e.g., other fish and invertebrates, organic wastes generated by the Project), can potentially affect the presence, abundance and health of fish.	*Change in Food Availability and Quality*	• Food quantity, quality and availability Project Area / LSA. • Volume of organic waste released and consumed.
• Various sources of fish mortality, injury or health effects may occur as a result of planned offshore oil and gas related	*Change in Fish Mortality, Injury, Health*	• Levels of fish injury or mortality.

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
activities. These could include those resulting from: ○ direct environmental changes from the Project (e.g., discharges of drill cuttings smothering benthic invertebrates, ○ fish injury through contact with Project related noise) ○ other possible direct and indirect effects on fish (e.g. emissions resulting in reduced availability of quality of fish habits or food sources, or contamination of fish and their habitats). • Fish species may also be affected by aquatic invasive species that compete for habitat and food resources.		• Numbers of individuals and species present in the Project Area or LSA. • Predator numbers and levels of predation. • Occurrence and success of key life history stages (e.g., feeding, reproduction) by any fish affected by the Project.
• Some individuals may be attracted to offshore facilities by associated environmental changes (such as food or habitat availability). • Conversely, others may avoid the area because of the associated noise or other disturbances in the marine environment as a result of the Project.	*Change in Fish Presence and Abundance (Behavioral Effects)*	• Individuals and species present and overall species diversity in the LSA and RSA. • Overall spatial and temporal distribution patterns in the LSA and RSA. • Occurrence and success of key life history stages (e.g., feeding, reproduction) by any fish affected by the Project.

An overview of the potential for each of the Project's planned components and activities to result in one or more of the above noted potential environmental effects on this VC is presented in Table 8.2.

Table 8.2 Potential Project-VC Interactions and Associated Effects: Marine Fish and Fish Habitat

Planned Project Component / Activity	Potential Environmental Effects			
	Change in Habitat Availability and Quality	Change in Food Availability and Quality	Change in Fish Mortality, Injury, Health	Change in Fish Presence and Abundance (Behavioral Effects)
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●	●	●

Planned Project Component / Activity	Potential Environmental Effects			
	Change in Habitat Availability and Quality	**Change in Food Availability and Quality**	**Change in Fish Mortality, Injury, Health**	**Change in Fish Presence and Abundance (Behavioral Effects)**
Drilling and Associated Marine Discharges (including fluids and cuttings)	●	●	●	●
Vertical Seismic Profiling			●	●
Well Testing			●	
Well Abandonment or Suspension				●
Supply and Servicing			●	●

8.3 Environmental Effects Assessment and Mitigation

The following sections provide an assessment of the potential effects of the Project (planned components and activities) on marine fish and fish habitat. Mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered in an integrated manner within and throughout the environmental effects analysis. The environmental effects assessment for accidental events for all VCs, including this one, is presented separately in Chapter 16.

8.3.1 Approach and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on the consideration of the nature, scale and timing of the Project's planned components and activities (Chapter 2), and the existing environment for this VC (Section 6.1). This analysis has focused on identifying any anticipated changes to the existing biophysical environment resulting from planned Project activities and emissions, as well as the various aspects of the Project that may result in these. This includes potential Project-VC interactions that may, through one or more associated pathways, lead either directly or indirectly to overall effects on the presence, abundance, diversity, health or other aspects of fish and fish habitat at the individual or population levels.

In doing so, this assessment considers what is known and can reasonably be deduced about the presence, abundance and distribution of fish species and habitats within and around the LSA and broader RSA, with a focus on any particularly important or sensitive species and components and those with the potential to be affected by the Project and its various associated environmental interactions. The assessment and description of potential environmental effects and the identification of mitigation has also been informed by a review of the existing and available literature and other existing knowledge, including past scientific studies and monitoring initiatives that have investigated and documented the actual effects of such activities and on marine fish and their habitats. Structurally, the environmental effects assessment subsection for each planned Project component/activity is organized with this initial "literature review" coming first, followed by the associated prediction of the potential effects on the VC. Each planned component of the Project is considered in terms of its potential for interactions with, and potential effects on, the VC, with a focus on the various potential environmental changes identified in the previous section.

To provide additional, Project-specific information and analysis related to the nature and extent of drill cuttings disposition resulting from the Project, drill cuttings dispersion modelling was undertaken at two representative well sites within the Project Area to evaluate the potential dispersion and eventual seabed "footprint" of these cuttings for various seasons (Amec Foster Wheeler 2017, see Appendix D). The results of this modelling are summarized and utilized in this VC chapter to assess the potential effects on benthic habitats and biota associated with the cuttings footprint (including its location, extent, and thickness) and the possible ecological implications of these seabed interactions (see Section 8.3.4 below).

In other cases, the environmental effects assessment reflects a more regional, issues-based and somewhat "mitigation-centric" approach. This is the most effective assessment approach in this case given both the current stage of Project planning and design (i.e., specific wellsite locations are not yet determined and defined) and the existence of effective mitigation measures to avoid or reduce potential adverse environmental effects. In terms of the latter, many of these mitigations are standard in the offshore oil and gas sector off Newfoundland and Labrador and elsewhere (due to regulatory requirements or otherwise) and which are proven to help avoid or reduce any such effects. In such cases, the effects assessment identifies the potential environment issues or interactions, determines the relevance and outcomes of the use of such mitigations, and considers the potential for residual effects to occur. A key focus of the analysis in such cases is on evaluating the potential (ecological) consequences of these environmental changes, based on their likely nature, scale, and duration, and especially, their potential to adversely affect important and sensitive aspects of this VC in a way that may result in significant adverse environmental effects.

As described in Section 2.5 of this EIS, given the current stage of planning and design for the various aspects of this multi-year exploration program, the EIS includes and assesses various options and approaches (e.g., types of MODU). It also includes and considers any potential variation in the possibility, nature and degree of environmental interactions and resulting effects between species and species groups and/or in different parts of the Project Area and LSA or at different times of the year, where relevant. Fish species at risk are again considered integrally within the environmental effects assessment for this VC, although these species are again given particular attention and emphasis in the identification, analysis and evaluation of potential environmental effects and any required mitigation measures.

8.3.2 Summary of Key Mitigation

Key mitigation measures that will be implemented to help avoid or reduce potential environmental effects on marine fish and fish habitat include:

- The Project will be planned and implemented so as to avoid or minimize environmental discharges and emissions from its associated operations and activities. This will be achieved through compliance with relevant regulations and standards (Section 2.9) and company procedures (Section 1.1) regarding materials selection and use, waste management, and discharge prevention and management for any potential liquid, solid or air emissions. This will include:

- The selection and screening of chemicals will be undertaken pursuant to the OCSG. Where technically feasible, lower toxicity drilling fluids and chemicals will preferentially be used.

- Treating operational discharges (such as sewage, deck drainage, bilge / cooling water, wash fluids, produced water, other waste) prior to release in compliance with the OWTG, MARPOL and other applicable regulations and standards.

- Oil-water separators will be used to treat contained oil-contaminated fluids, with collected oil properly stored and disposed of.

- Appropriate measures for the handling, storage, transportation and on-shore disposal of solid and hazardous wastes will be implemented throughout the Project.

- Complying with the *Canadian Environmental Protection Act*, the *National Ambient Air Quality Objectives*, the Newfoundland *Air Pollution Control Regulations* and MARPOL for specified criteria air contaminants in exhaust emissions and relevant regulations under MARPOL.

- During drilling activities that occur after the riser has been installed, SBM associated drill cuttings will be returned to the MODU and treated in accordance with the OWTG before being discharged to the marine environment. SBM drill cuttings are typically discharged below the sea surface in order to maximize their dispersion and thus, to help avoid or reduce any associated surface sheen and their accumulation on the seabed.

- Maceration of sewage and kitchen waste will be conducted in accordance with MARPOL and the OWTG.

- The frequency of vessel and aircraft traffic transits associated with the Project will be minimized to the extent possible. Low-level aircraft operations will also be avoided, wherever possible and feasible.

- Project-related artificial lighting will be minimized to the greatest extent possible without compromising safety.

- Local vessels, MODUs and equipment will be used where technically suitable and available to reduce the potential for introduction of aquatic invasive species. All foreign vessels used for the Project operating in Canadian jurisdiction will comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act, 2001* during any ballasting and de ballasting activities. This may include requiring all foreign vessels and MODUs to carry out ballast tank or system flushing prior to arriving in Canadian waters to mitigate the spread of alien invasive species.

- Prior to the start of drilling activity, a seabed investigation will be undertaken with a drop camera / video system to investigate the potential presence of sensitive benthic organisms or habitats in the immediate area of the wellsite (such as corals and sponges).

- Should coral colonies (as defined below) be observed within or in proximity to a planned wellsite location, a 100 m “set-back” from these organisms will be applied to avoid or reduce the potential for direct interaction with sensitive organisms or other potential effects. The implementation of this mitigation will adhere to the C-NLOPB’s standard regulatory guidance on this matter, as follows:

  Drilling activities, including moorings, shall not occur within 100 m of coral colonies without the prior approval of the Chief Conservation Officer. A coral colony is defined as:

  - *Lophelia pertusa reef complex; or*
  - *Five or more large corals (larger than 30 centimeters in height or width) within a 100 square metre area.*

- If moving the wellsite in this manner is not feasible, Nexen will consult with the C-NLOPB to determine an appropriate course of action.

- During any associated well testing, any produced hydrocarbons and small amounts of produced water will be flared using high-efficiency burners. If there is a significant amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge.

- For any required VSP surveys using seismic sound arrays, Nexen will operate in compliance with the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*. Key mitigations that will be applied include:

  - Seismic sound levels will be kept at the minimum level possible based on the associated technical requirements for the survey.

  - At the commencement of the VSP survey, a gradual "ramp-up" procedure of the seismic sound array will be implemented to allow any mobile marine animals to move away from the area if they are disturbed by it.

  - There will also be a planned shut-down of the seismic sound arrays or reduction to the smallest, single source element during any required maintenance activities.

- If removal of the wellhead is required as part of abandonment procedures, it will be completed via mechanical separation (i.e., cutting, as opposed to the use of explosives).

8.3.3 Presence and Operation of MODUs

As described in Chapter 2, the Project will include exploration wells on various Nexen-operated licences (ELs 1144 and 1150) which will be drilled using one or more MODUs. Over the course of its temporal duration, it is estimated that up to 10 wells could be drilled as part of the Project. The initiation and completion of the proposed offshore exploration program will involve the positioning and operation of the MODU(s) which may include the use of semi-submersibles and/or drill ships, and at times there may be multiple MODUs (potentially of multiple types) operating simultaneously.

The presence and operation of the MODU and supporting vessels may result in a number of associated environmental interactions and emissions. The main potential interactions between the presence and operation of the MODU and marine fish and fish habitat relate to the associated underwater noise and vibrations, lighting and other environmental discharges that will or may be associated with these activities, as well as associated interaction with the seabed itself (such as through any required anchoring) and any benthic species and habitats.

8.3.3.1 Overview of Potential Effects and Existing Knowledge

Underwater Noise and Vibrations

The positioning, presence and operation of a MODU produces underwater noise and vibrations from equipment operations, dynamic positioning systems (as required) and drilling operations.

Anthropogenic noise in the marine environment such as that which may be associated with drilling activities, vessel traffic and other equipment used during offshore oil and gas exploration activities is transmitted through water and may result in disturbances to marine biota. There is, however, no direct evidence of mortality to fish as a result of continuous underwater noise from such activities (Popper and Hastings 2009; Popper et al 2014). Typical sound levels from offshore drilling activities are generally below estimated received sound exposure guidelines for injury to fish, those that have been established for recoverable injuries (170 dB re 1 µPa for 48 hr) and temporary hearing threshold shift (158 dB re 1 µPa for 12 hr) (Popper et al 2014). Given the known behavioural (avoidance) responses of some fish species to underwater noise (as described below), mobile species that may be present within this zone of influence would be expected to move out of the area if they are disturbed. Indeed, the presence and progression of the various mobilization and set-up activities at a planned wellsite location prior to the start of drilling activities also mean that any individuals in the area will have been exposed to these lower levels of sound and have an opportunity to move away prior to being affected through potential injury or otherwise. Although some larval stages and immobile (particularly benthic) species may be unable to avoid such exposure, direct physical damage to fish as a result of many types of anthropogenic noise in the marine environment is limited, including from marine activities (such as seismic surveys) and associated sound levels that are much higher than those that will be associated with drilling activities such as those that will occur as part of this Project.

A variety of behavioural responses by marine fish to anthropogenic underwater sound have been reported in literature and anecdotal reports. These responses vary by species, life stage, intensity of sound, distance from source and other factors. For example, herring species have a higher hearing sensitivity than salmonids (trout, salmon) and gadids (cods) (Popper and Hastings 2009). These behavioral effects include possible avoidance or attraction by individual fish, as well as possible physiological effects when fish are continually exposed to noise (Clark et al 2016). Noise from marine vessels and other sources has, for example, been shown to mask the acoustic sensory environment of fish and invertebrates and affect behavior (Slabbekoorn et al 2010, Wale et al 2013a, 2013b; Morley et al 2014), causing avoidance by some species and possible associated effects on fish and their activities (including feeding, reproduction, communication). Overall, however, these short term and low frequency noises appear to elicit temporary avoidance due to startling effects, with longer-term avoidance potentially occurring if the noise is of higher frequency or continuous (Misund et al 1996; Wilson and Dill 2002).

Although there remains an incomplete understanding of the environmental consequences of underwater noise (Slabbekoorn et al 2010; Morley et al 2014), the effects of anthropogenic noise in the marine environment can be short-lived and transient in nature, and reversible once the noise source has been removed or reduced, decreasing the potential for any detrimental effects (Williams et al 2015).

Light Emissions and Other Environmental Discharges and Interactions

The presence of a MODU and its associated lighting and other environmental discharges (including any organic waste and food waste material) may result in the attraction of fish and invertebrate species. Migrating individuals, plankton, and pelagic species may be attracted to the lights of the MODU shining on the water, and invertebrates may become attached to the subsea structure as it provides a surface for colonization. The combination of MODU colonization opportunities and artificial light emissions from the operating decks and navigation may create a “reef effect” in which fish may aggregate underneath in response to increased foraging and shelter opportunities (Picken and McIntyre 1989; Røstad et al 2006; Slabbekoorn et al 2010), even in areas of elevated underwater noise. Lighting around the MODU may attract phototaxic plankton, and may provide increased opportunities for prey capture by fish and other species (Keenan et al 2007; Cordes et al 2016). For example, yellowfin tuna in the Gulf of Mexico are known to aggregate around production platforms as they are sight feeders that have more foraging opportunities in the associated well-lit surrounding waters (Hoolihan et al 2014). Furthermore, a MODU may provide new habitats for various organisms that increase overall food production in the area, leading to increased abundance (Bomkamp et al 2004; Sammarco et al 2004; Punzo et al 2015).

Safety zones that are generally established around MODUs that exclude other commercial marine traffic and fishing activity may also provide a temporary refuge for fish (Cordes et al 2016). In these instances, fish species may benefit through increased availability of shelter and food for juveniles, and by the decreased fishing pressure on adults. Any such positive effects are usually temporary, however, as removal of the offshore structure from the wellsite will usually result in local fish and invertebrate abundance and diversity returning to levels prior to enhancement (Bomkamp et al 2004). Conversely, the attraction of marine biota to the MODU or vessels and their lighting or other environmental discharges also increases their potential for interaction with emissions and disturbances, especially possible contamination through interaction with liquid discharges, as described further in Section 8.3.4.

Interaction with the Benthic Environment

The installation and positioning of MODUs may involve the use of anchoring/mooring systems in certain water depths. The placement of such anchors can disturb bottom habitats and cause injury or mortality to benthic invertebrates, including corals and sponges (Ragnarsson et al 2017). Injury or mortality to benthic invertebrates may provide a temporary increase in food for predatory and scavenging species (Clark et al 2016). The small seabed footprints associated with setting anchors and the anchors may also provide limited increases in habitat complexity and provide habitat for species that will further support higher trophic levels. This potential effect is localized to the small footprint and is only for the duration during which the infrastructure is in place (Bomkamp et al 2004). While recovery and recolonization of habitats is dependent on distance to source species and species densities, recovery is often slow in deep and cold water environments in comparison to shallow shelf environments (Clark et al 2016).

Aquatic Invasive Species

Invasive species can threaten aquatic ecosystems, occupy habitats or out-compete native species, introduce new diseases and alter ecosystem processes (Bax et al 2001). In offshore environments, species may be transmitted to the platform through ballast water or on the hull of vessels servicing the offshore area (Sammarco et al 2004) or through local recruitment. Increased habitat due to the presence of a MODU or vessels may also provide "stepping stone" habitats to increase ranges of colonizing native and invasive invertebrates that are not normally able to traverse large expanses of open water (Sammarco et al 2004; Cordes et al 2016).

Aquatic invasive species may show rapid population growth in the absence of natural predators, and may soon become established to the point where eradication is difficult or impossible. Local and international marine transport in general is implicated in many of the accidental introductions of marine invasive species, as ship hulls and bilge water serve as vectors for the range expansion of such species (Bax et al 2001; McKenzie et al 2011; Benoit et al 2012) to new areas. Several invasive species have been identified off Newfoundland and Labrador (Templeman 2010), all of which have been shown to have effects on the native species and ecosystems, although these effects are generally thought to be more important to the coastal benthic communities as compared to in the open ocean (Templeman 2010).

8.3.3.2 Residual Environmental Effects Assessment

The planned presence and operation of the MODU(s) as part of the Project will introduce additional underwater noise into the surrounding marine environment (see Appendix E), which may have implications for fish in the immediate area. As described above, underwater noise levels resulting from drilling activities are not likely to result in injury or mortality to marine fish, and mobile species and life stages will be able to move away from the area temporarily if they are disturbed by these noise levels. Although Project-related noise may therefore result in a degree of behavioural effects on some individuals and species, large scale and population level disturbances are unlikely as a result of this drilling activity due to its relatively localized and temporary presence at any one location. For these reasons, it is considered very unlikely that fish will be displaced from habitats or disrupted during key activities over extended areas or periods, or be otherwise affected in a manner that causes negative and detectable effects to fish populations in the region.

The presence of the MODU in combination with lighting effects and other emissions may have localized positive effects on fish abundance and diversity in the LSA by creating a "reef effect" that aggregates plankton and increases invertebrate colonization resulting in increased local productivity and food sources. When combined with the safety zone established around the drilling, some fish species may benefit through increased availability of shelter and food for juveniles, and by the decreased fishing pressure. Any such positive effects will be temporary, however, and the attraction of marine biota to Project-related MODUs or vessels also increases their potential for interaction with Project related emissions and disturbances, as described further below.

As noted previously, the potential positioning and stabilization of a MODU using anchors also has the potential to affect the benthic environment. A "coral garden" is generally defined as a relatively dense aggregation of colonies or individuals of one or more species covering an area of at least 25 square metres (Det Norske Veritas 2013; Kenchington 2014) within a 100 square meter area. Sponge grounds

are characterized by the OSPAR Convention as consisting of habitat forming glass sponges (Class Hexactinellida) or demosponges (Class Demospongiae) in dense aggregations of 0.5-24 individuals per meter squared (OSPAR Commission 2010). Investigations on the Sackville Spur off the Flemish Cap indicated that aggregations of 15 individuals per square meter were considered a threshold for supporting epibenthic megafauna (Beazley et al 2015).

For this Project, a somewhat higher potential for interactions with habitat forming coral and sponge species exists in areas such as the slopes of the Newfoundland Shelf, Flemish Pass and Flemish Cap which are more likely to have higher densities of coral and sponge species as compared to other parts of the Project Area / LSA and the Eastern Newfoundland Offshore Area in general (Section 6.1.6). In areas where coral gardens or sponge grounds are known or likely to be present, prior to the start of a drilling campaign a seabed investigation survey will be undertaken with an underwater video (ROV) system to investigate the potential presence of these aggregations in proximity to the planned wellsite and/or any moorings (if required). Should such organisms be observed within or in proximity to the planned wellsite location, a 100 m “set-back” from these will be applied to avoid or reduce the potential for direct interaction with these species or other potential effects (such as smothering or sedimentation from drill cuttings disposal or sedimentation). If moving the wellsite is not feasible, Nexen will consult with the C-NLOPB to determine an appropriate course of action.

In cases where dynamic positioning is used to position and stabilize the MODU and/or support vessels, the interactions with the benthic environment would be limited as mooring would not be required. Therefore, potential interactions with benthic habitats would be limited to the area of the well site itself. In shallower parts of the Project Area, the use of anchoring systems will result in direct contact with the seabed. As noted above, however, underwater surveys will be conducted prior to anchoring operations to ensure that anchors will not be set in sensitive coral or sponge habitats. As the Project Area overall is an area of relatively low seabed complexity (Section 6.1.6), the introduction of subsea infrastructure may provide opportunities for colonization and increased distribution of benthic species that have pelagic eggs or larvae. This effect would be temporary for the length of drill operations, but the combination of increased colonization opportunities and local enrichment (see below), may support faster recovery.

Expected and potential environmental emissions and discharges associated with the Project will include drilling wastes (fluids and cuttings, see next section) and cement, other liquid wastes (produced water, bilge and deck drainage, ballast water, BOP fluids, sewage, cooling water and fire control water), atmospheric emissions (exhausts from equipment), and solid wastes including food and other non-hazardous waste. These emissions are described in some detail in Section 2.9. All waste liquids will be treated as required and discharged in accordance with the OWTG and MARPOL, thereby reducing any potential effects on the marine environment. Grey wastewater from the galley, washing and laundry facilities and black wastewater from accommodations will be macerated prior to discharge. Although discharges of organic wastes may lead to localized organic enrichment (Peterson et al 1996), no adverse effects are anticipated as volumes would be quite small and will be highly dispersed in this relatively deep-water and dynamic marine environment (Section 5.5), resulting in overall low potential for interactions with or effects on marine fish and their habitats. Each of the MODUs and vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a Waste Management Plan in place that will be strictly adhered to throughout the life of the Project. Hydrocarbon or other contaminant levels are strictly regulated by MARPOL and OWTG and any wastewater discharges from the MODU will be treated prior to release.

Bilge and deck drainage water that comes into contact with MODU equipment may become contaminated with oil. The bilge and drainage water will be separated from oil before discharge to meet the limits prescribed by the OWTG and discharged in accordance with OWTG and MARPOL.

As with any ocean-going vessel and associated marine traffic, the presence and operation of Project-related MODUs and vessels could result in the accidental introduction and spread of invasive species. For this Project, the required supply and services vessels will likely be sourced from the existing "pool" of locally based ships that service the oil and gas industry for the Canada-NL Offshore Area and operate in Canadian waters, mostly offshore Newfoundland. However, internationally sourced MODUs and vessels may be used and therefore from other regions. Prevention is considered to be key in controlling the introduction and spread of such species, as control of established populations is often costly and ecologically risky (Bax et al 2001). Although the likelihood that a Project vessel will result in the introduction and spread of an invasive species is relatively low, all Project vessels carrying ballast will use and comply with the *Canada Shipping Act, 2001*, the associated *Ballast Water Control and Management Regulations*, and International Maritime Organization (IMO) anti-fouling guidelines to mitigate any potential spread of invasive species.

In summary, the potential effects on marine fish and fish habitat resulting from the presence and operation of the MODU and standby vessel(s) are predicted to be primarily adverse but low in magnitude, localized to within the LSA, of short to medium term duration, occurring regularly during MODU operations, but reversible. This prediction is made with a high level of certainty.

8.3.4 Drilling and Associated Marine Discharges

Specific wellsite locations will be selected as Project planning and design activities move forward, based on existing and new seismic survey data and information derived from previously drilled wells in the region. Once the drill site clearance has been completed and the MODU has been positioned, the drilling processes commence, with each well being drilled in sections by gradually reducing the size of the well bore. Drilling fluids lubricate and cool the drill bit and hole, circulate cuttings and carry them back to the surface, and help to maintain appropriate pressure in the well. The initial top hole sections involves a large diameter hole for the first part of the well. These initial sections of the well are typically drilled using seawater or a WBM. As the initial (conductor) section of a well is drilled without a riser in place, the WBM and cuttings are discharged directly to the seabed.

When the riserless sections have been completed to the depth where the rock formation strength is sufficient, two or more casings are run before the BOP is installed. The wellhead is also installed at seabed and the riser and BOP are then installed onto the wellhead. The riser is a large diameter pipe that acts as a conduit connecting the MODU to the wellhead through the water column, and the wellhead provides structural integrity to support the BOP and pressure integrity for drilling operations. A BOP is a system of high pressure valves that prevent water or hydrocarbons from escaping into the environment in the event of an emergency or equipment failure. At intervals along the well, casing is cemented in place to reinforce the wellbore. Once the riser has been installed, the remaining sections of the well will be drilled to predefined depth using SBM, in which case the fluids and cuttings can be returned to the surface and onto the MODU for recovery and reuse.

The planned release of drilling waste materials including cuttings and fluids, represent one of the main potential interactions with marine fish and fish habitat during offshore drilling programs. The primary

interactions from discharge of drill cuttings include sedimentation and cuttings deposition with associated seabed disturbance (smothering); chemical toxicity; and bioaccumulation (uptake of contaminants by fish and the presence or perception of taint).

8.3.4.1 Overview of Potential Effects and Existing Knowledge

As noted above, there are two general types of drilling fluids used in the offshore: 1) WBMs and 2) non-aqueous fluids (NAFs), which include SBMs (Neff et al 2000). WBMs are generally used only for the top sections (conductor and surface sections) of the wells, whereas SBMs may be used for deeper (intermediate and production) sections because of their better performance in various situations (CAPP 2001; DeBlois et al 2014). As also described in Section 2.9, all chemicals that will be utilized as part of the Project – including any used in drilling fluids – will be screened and selected in accordance with the OCSG and in accordance with Nexen's chemical screening and management practices.

Drilling solids (cuttings) are the particles of crushed rock produced from the grinding action of the drill bit as it penetrates subsurface rocky formations (Neff et al 2000; Peralba et al 2010). The particle size, minerology and chemistry of drill cuttings depend on the geologic strata being penetrated (Neff et al 2000). Once formed, the drill cuttings are carried from the bottom of the well to the surface in a suspension of drilling fluid (Holdway 2002; Peralba et al 2010). Drill cuttings are typically regarded as toxicologically inert, however adhered drill fluids may be toxic depending on the type of drilling fluid being used (Neff et al 2000; Neff 2008).

Water-Based Drilling Fluids

WBMs are primarily comprised of seawater, along with other additives including bentonite (clay), barite and potassium chloride (Neff 2008; 2010). Other approved chemicals are also added as required to control and achieve the required fluid properties (Trefry et al 2013; Whiteway et al 2014).

WBMs have varied effects on marine organisms, but due to the non-toxic nature of the drilling fluid components (Neff 2010), WBMs are not likely to result in contamination (Holdway 2002; Trannum et al 2010, 2011; Bakke et al 2013; Purser 2015). Exposure to WBMs at low concentrations has, for example, not shown toxicity to sea scallops, polychaetes, amphipods, shrimp and various other fish species (Cranford et al 1999, Neff 2010). The acute toxicity potential in relatively high concentrations of barite was also tested and found to be non-toxic to capelin, snow crab larvae or planktonic jellyfish after 24 hours of continuous exposure (Payne et al 2006). Possible sublethal effects, including reduced growth rates and altered foraging behaviours, have been observed in crustaceans, scallops and haddock that were exposed to high concentrations of WBMs or its components for 96 hours to 68 days, but at experimental exposure levels well beyond what marine organisms would potentially encounter in the environment (Cranford et al 1999; Neff 2010). While dependent on local hydrodynamics and particle properties, elevated levels of barium originating from drill fluids have been observed up to 600 m from the well in some drilling operations (Ragnarsson et al 2017).

Due to the physical properties of the drilling fluid components, associated metals are also not readily incorporated into tissues, limiting the availability of metals for bioaccumulation (Neff 2010, Edge et al 2016) although this may be somewhat species-specific. Infaunal species, including polychaetes and bivalves that have limited ability to migrate away from the disturbance, may accumulate metals from WBMs (Neff et al 1985; Schaanning et al 2002; Ruus et al 2005) and *Lophelia pertusa* corals have been

shown to incorporate barite particles as far away as 600 m from the drill site (Ragnarsson et al 2017). However, mobile benthic feeders, including snow crab are not expected to accumulate metals from WBM because of the potentially small area affected from exploratory drilling programs compared to the wider home range of the species (Ennis et al 1990; Trannum et al 2010; Bakke et al 2013). Environmental effects monitoring data have also indicated that the area of WBM effect where there was an increase in metal levels is generally limited to within 250-500 m of the drill site (LGL Limited 2003).

Potential effects to marine organisms are suggested to be higher in suspension feeding marine invertebrates including sponges and corals (Cranford et al 1999; Neff 2010). Continuous exposure of the sponge *Geodia barretti* to the barite component of WBMs, for example, resulted in evidence of toxic and stress effects (Edge et al 2016). These effects were reduced or not observed at lower barite concentrations (less than 10 mg/L) or if the exposure was intermittent (Edge et al 2016). Many corals are considered sensitive to suspended sediments with increased larval mortality and change in feeding behaviour resulting from exposure to WBM (Raimondi et al 1997, Neff 2010; Buhl-Mortensen et al 2015; Järnegren et al 2016; Ragnarsson et al 2017), although some corals have higher tolerance to drill fluid deposition (Allers et al 2013).

While relatively non-toxic, degradation of organic components in the drill fluids can also initiate eutrophication responses that can create localized anoxic environments (as described below in Sedimentation and Burial) (Schaanning et al 2008; Trannum et al 2010). These biological effects of WBMs are not normally found beyond about 250-500 m from a drilling platform in projects where cuttings piles are formed (Hurley and Ellis 2004; Schaanning et al 2008; Jorissen et al 2009; Santos et al 2009; Trannum et al 2010; Ellis et al 2012; Bakke et al 2013; Deblois et al 2014).

Synthetic-Based Drilling Fluids

SBMs were originally developed to replace oil-based muds (OBMs) that were historically used in drilling activities. The toxic components of the OBMs have been essentially removed in the synthetic based fluids, resulting in drilling fluids that have lower acute toxicity (Tsvetnenko et al 2000; Hamoutene et al 2004; Paine et al 2014; Tait et al 2016). Potential base fluids for SBMs may include esters, poly alpha olefins, internal olefins, linear alpha olefins and others.

Acute toxicity of SBMs is also considered to be relatively low based on laboratory experiments and field evaluations of SBM-associated drill cuttings piles (Still et al 2000; Tsvetnenko et al 2000; Hamoutene et al 2004; Paine et al 2014; Tait et al 2016). Lobsters injected with high levels of SBM, for example, did not change aspects of lipid and protein metabolism or have any other adverse health effects after approximately 20 days (Hamoutene et al 2004). Toxicity experiments with fish indicated that acute toxicity of SBMs was generally low (96-h LC50 toxicity of >30,000 mg/L, Jagwani et al 2011), but there were potential health effects with chronic exposure to SBM associated cuttings (Jagwani et al 2011; Gagnon and Baktyar 2013; Vincent-Akpu 2013). Any potential effects are likely to be temporary in nature as SBMs biodegrade within a few years (Terrens et al 1998; Ellis et al 2012; IOGP 2016). The distance of biological effect varies with drilling programs as demonstrated by the results of a DFO study (Payne et al 2006) in the Jeanne d'Arc Basin area on the Grand Banks, which found that any significant sediment toxicity stemming from the use of synthetic type (e.g., IPAR) drilling fluids in this area should be confined to a range of tens of meters from any cuttings pile deposited on the seabed below the MODU. Another study by the Society of Petroleum Engineers (SPE) (Nedwed et al 2006) of cuttings and associated fluid disposal and its environmental effects in deep water (950 m) found that cuttings

drilled with SBMs discharged into deep water had a very limited environmental effect. Therefore, SBM toxicity is not a primary concern of drilling fluids discharge.

The potential effects of the disposal of SBM-associated drill cuttings are possible alteration of marine habitats through smothering (see below) and creation of anoxic environments through local eutrophication from degradation of SBM organic components (as described below in Sedimentation and Burial) (Schaanning et al 2008; Ellis et al 2012). Previous studies and monitoring programs have shown that the nature and magnitude of these effects on benthic invertebrates and their habitats are linked to the thickness and extent of the associated cuttings pile that may accumulate on the seabed following discharge (Smit et al 2006; Schaanning et al 2008) and that the response of the benthic community to drill cuttings discharges can be dependent on the types of SBM drilling fluid used (Holdway 2002; Netto et al 2009). Similar to deposition of WBMs, the area of biological effect is generally limited to less than one kilometre of the SBM discharge source (Deblois et al 2014; Tait et al 2016). Deblois et al (2014) also did not detect any biological effects in Icelandic scallop or American plaice collected one kilometre from the Terra Nova oil development resulting from SBM discharge. Tait et al (2016) observed SBM concentrations diminished greatly between 600-800 m from the well site, indicating a localized area of effect.

Sedimentation and Burial

The potential biological effects of sedimentation and burial from discharge of drilling fluids and associated drilling cuttings are particularly relevant to the benthic environment (IOGP 2016). Immobile or sessile bivalve and infaunal species are particularly sensitive as they have limited capability to move away from the disturbance (Smit et al 2006). The physical properties of the cuttings and any residual fluids on them may also inhibit escape from burial in comparison to natural sedimentation (Gates and Jones 2012). Sessile species are often suspension feeding organisms with feeding structures that may become clogged with suspended and re-suspended sediments resulting from the drill cuttings discharge and sedimentation (Neff et al 2000; Smit et al 2006).

Depending on the receiving environment, the addition of SBM and WBM drill cuttings may change the substrate composition of the seabed, altering benthic community composition as it responds to changing fish habitat (Smit et al 2006, 2008). In deep water environments drill cuttings are generally well dispersed with potential for redistribution with bottom currents (Rajnauth et al 2005; Pivel et al 2009). The degradation of organic components in SBMs by bacteria increases local oxygen demand resulting in low oxygen or anoxic environments in areas of cuttings piles (Schaanning et al 2002, 2008; Trannum et al 2010). Macrofauna surveys of a drilling operation in the Faroe-Shetland Channel, for example, found that smothering and burial of organisms was primarily within 100 m from the drill cuttings source with maximum cuttings pile heights of 1.5 m, with lesser effects up to 250 m (Gates and Jones 2012). Oxygen penetration of drill cuttings at the well site was measured to be very low (less than 0.5 cm) compared to reference sediments (2.5-3.4 cm), indicating bacterial driven anoxic conditions (Tait et al 2016). This resulted in overall species richness decline within 800 m of SBM drill cuttings deposition, and infaunal communities dominated by hypoxia-tolerant polychaetes. WBM sedimentation layer thickness (3-24 mm) has also been negatively correlated with species abundance and diversity associated with eutrophication and oxygen depletion from degradation of WBM organic components (Trannum et al 2010). The overall result of these potential effects is a localized decreased species abundance and diversity of benthic organisms within approximately one kilometre of the source (Neff

et al 2000; Holdway 2002; Schaanning et al 2008; Trannum et al 2010; Gates and Jones 2012; Larsson et al 2013; Cordes et al 2016; Tait et al 2016).

Corals and sponges are particularly sensitive to sedimentation and burial in the marine environment (Larsson and Purser 2011; Allers et al 2013; Bell et al 2015; Purser 2015; Liefmann 2016; Järnegren et al 2016; Ragnarsson et al 2017), as they are sessile, suspension feeding and slow growing. The deep sea cold water coral *L. pertusa* has been studied extensively in response to drill cuttings in the North Sea and Gulf of Mexico (Larsson and Purser 2011; Allers et al 2013; Purser 2015) and provides an indication of potential coral response to cuttings discharge. Laboratory experiments indicate that coral larvae are sensitive to suspended drill cuttings with exposure leading to clogging of *L. pertusa* larvae feeding and swimming structures, eventually leading to larval mortality (Larsson et al 2013; Järnegren et al 2016). However, adult corals are often able to tolerate short term exposure to certain amounts of sedimentation and anoxic conditions without any visible detrimental short-term effects or mortality due to their efficient sediment clearing mechanisms (Brooke et al 2009; Allers et al 2013; Larsson et al 2013; Purser 2015).

Feeding responses to drill cuttings have also been variable depending on sediment load and ocean conditions (Larsson et al 2013; Baussant et al 2014; Buhl-Mortensen et al 2015). Chronic or high level sedimentation exposure may lead to sublethal effects including reduced growth rates and smaller oocyte size (Larsson et al 2013; Baussant et al 2014), however field observations have not shown degradation of *L. pertusa* coral reefs exposed to drill cuttings over time (Purser 2015). Studies with suspended mine tailings on the soft coral *Duva florida*, and a gorgonian coral *Primnoa resedaeformis*, species found in the Northwest Atlantic, indicated that small sharp sediment particles were more harmful than smooth edged particles to corals and resulted in changes in feeding behaviour and increased mortality (Liefmann 2016).

Potential effects of suspended sediments on sponges may include clogging of feeding structures, smothering, and abrasion (Bell et al 2015). Sponge tolerance for suspended and settled sediments vary with habitat, with species adapted to soft bottom habitats having a higher tolerance for re-suspended sediments (Bell et al 2015; Kutti et al 2015). *Geodia barretti*, a habitat forming sponge distributed on the slopes of the Flemish Cap and in the Flemish Pass (Knudby et al 2013), is adapted to cope with sedimentation events by reducing filter feeding and thus decreasing their intake of sediment particles (Tjensvoll et al 2013; Kutti et al 2015). However, introduction of sediment sizes atypical from natural conditions may reduce organism condition (Kutti et al 2015). Larval sponges are more sensitive to sedimentation, resulting in higher larval mortality and decreased settlement (Maldonado et al 2008; Bell et al 2015). Therefore, corals and sponges are often adapted to tolerate short term exposure to drill cutting sedimentation with potential effects on adults related to chronic exposure or high sedimentation and burial. Early life stages also show sensitivity to suspended sediments and sedimentation.

Previous studies indicate that sedimentation and burial effects from drilling fluids and cuttings on benthic invertebrates have mainly been localized to the vicinity of a drill cuttings pile area (Neff et al 2000; Holdway 2002; Schaanning et al 2008; Trannum et al 2010; Gates and Jones 2012; Larsson et al 2013; Cordes et al 2016; Tait et al 2016). An average well drilled on the Norwegian shelf, for example, where approximately 300 tons of cuttings were discharged, resulted in a cuttings pile radius of 50 m around the well head (Ragnarsson et al 2017). The cuttings pile, comprised mainly of large particles and flocculated solids that settle quickly, represented approximately 90 percent of the cuttings discharge and the remaining smaller, unflocculated particles were suspended in the water column for a

considerable period of time and disperse widely (Ragnarsson et al 2017). The degree of dispersion is highly dependent on size and density of particles and local hydrodynamics (Ragnarsson et al 2017).

Average burial depths of 6.5 mm are considered to be the predicted no effect threshold (PNET) for non-toxic sedimentation based on benthic invertebrate species tolerances to burial, oxygen depletion and change in sediment grain size (Kjeilen-Eilertsen et al 2004; Smit et al 2006, 2008). However, as some species may be more susceptible to shallower burial depths, an average PNET burial depth of 1.5 mm is suggested to be a more conservative approach to assessing drilling discharges (Kjeilen-Eilertsen et al 2004; Smit et al 2006, 2008). This level coincides with assessments on more sensitive coral species where injury observed with sedimentation of less than 6.3 mm (Larsson and Purser 2011).

Recovery and Recolonization

Recovery of areas of biological effect from SBM and WBM discharge varies considerably, as it is influenced by disturbance size and frequency, distance to source colonizers and local environmental conditions (Gates and Jones 2012). For example, well sites associated with hydrocarbon drilling activity in the deep sea Faroe-Shetland Channel produced cuttings depositional areas distributed within 250 m from the source with a maximum thickness of 1.5 m that resulted in smothering and burial of benthic organisms (Jones et al 2012). The cuttings piles were considerably smaller three years after the disturbance due to high current events, and fauna diversity was found to be similar as at undisturbed sites (Jones et al 2012). Increased recovery of megafauna diversity and densities were observed after 10 years at the site, however drill cuttings effects were still apparent indicating the area had not fully recovered (Jones et al 2012). Also, a drilling site in the Norwegian Sea that produced a cuttings pile distributed over 100 m from the well with cuttings depth of less than 0.5 m had reduced cuttings pile area and similar megafaunal densities to pre-drilling and background surveys three years after the deposition (Gates and Jones 2012). Gates and Jones (2012) also noted that the effects of the exploratory drilling on invertebrate density and diversity were confined to the extent of the cuttings pile itself.

Bottom currents may further aid in cuttings dispersion in some areas, minimizing any potential for long term effects due to burial by sediments. Mobile benthic organisms (such as shrimp) will also quickly recolonize a disturbed area if water quality is not permanently affected (Tait et al 2016). Opportunistic species that may be tolerant to pollutants like some polychaete and nematodes have also been shown to colonize a cuttings depositional areas within months (Kingston 1992). SBM components in drill cuttings have been observed to degrade quickly, with a greater than 40 percent biodegradation over 7-8 months after the cessation of drilling activity, thereby reducing toxicity over time (Daan et al 1996; Trannum et al 2010; Tait et al 2016). Terrens et al (1998) indicated that there was an absence of SBM esters in sampling sites 11 months after cessation of drilling, and recovery of crustaceans and nematodes was observed after only four months. The initial decrease in diversity and density of invertebrates was also limited to the drill cuttings pile that was within 100 m from the well site (Terrens et al 1998).

8.3.4.2 Residual Environmental Effects Assessment

The exploration drilling activities that will be associated with this Project will involve the use of both WBMs and SBMs at various stages of drilling the well. As described in Section 2.9, all chemicals that will be utilized as part of the Project – including drilling fluids – will be screened and selected in

accordance with the OCSG and in accordance with Nexen's chemical screening and management practices.

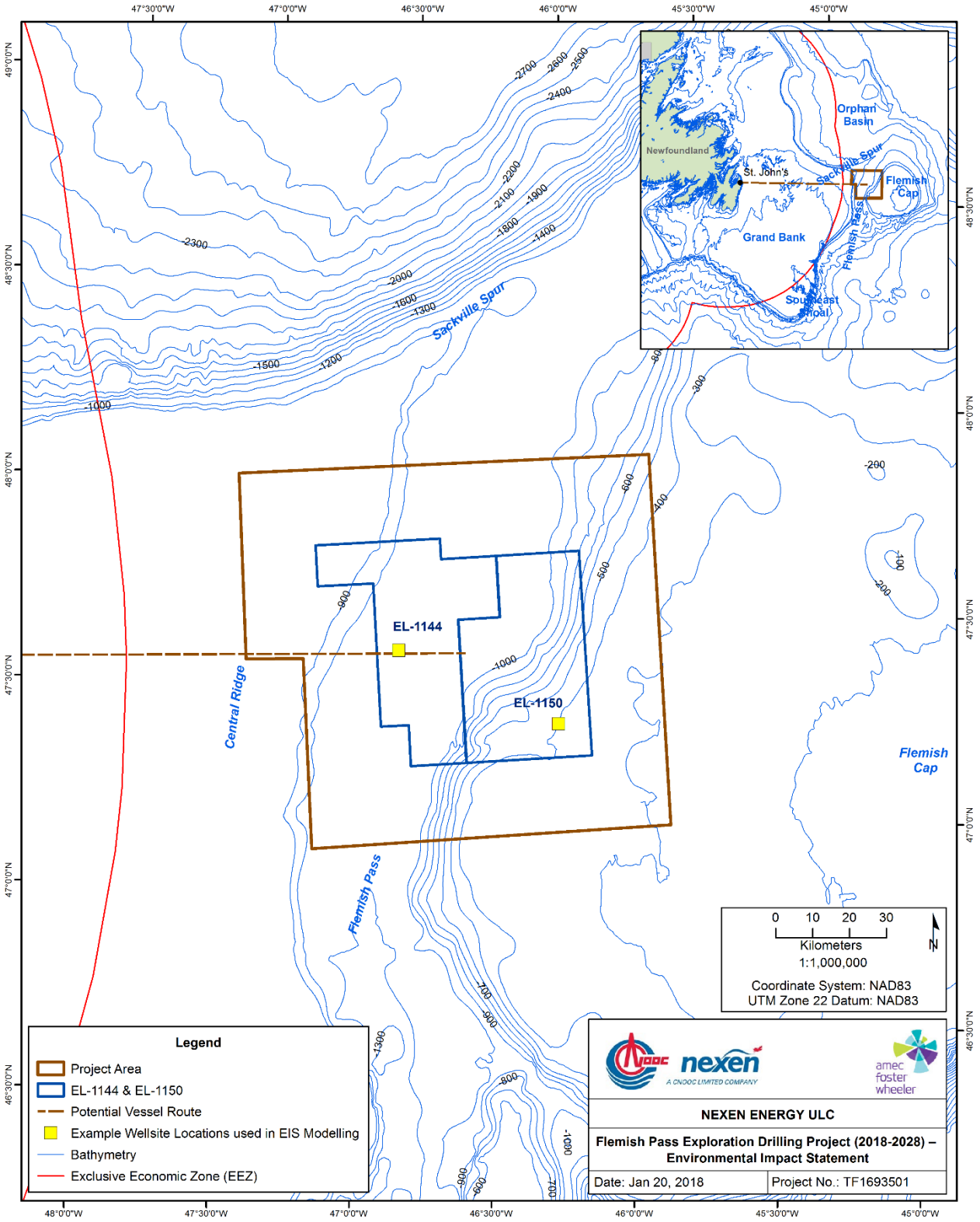
The initial sections of the well will be drilled using seawater or a WBM, and these drilling fluids and associated cuttings will be discharged directly to the seabed, as permitted under and in accordance with the OWTG. Any released WBM and WBM-associated drill cuttings resulting from the Project will not result in adverse effects from contamination of marine biota or habitats, as these materials are non-toxic, have low bioaccumulation and only localized biological effects (Deblois et al 2014). Once the riserless sections are complete and the riser is installed and in place, drill fluids and cuttings can be returned to the MODU for processing. Under the OWTG, other than residual base fluid retained on cuttings no whole SBM is permitted to be discharged to the sea. Therefore, once onboard the MODU, drill cuttings will be removed from the drilling fluids in successive separation stages using solids control equipment. The vast majority of the fluid will be reconditioned and reused, while any spent SBM will be returned to shore for disposal or recycling/reuse by the SBM supplier. SBM-associated drill cuttings are permitted to be discharged at the drill site provided they are appropriately treated prior to discharge in accordance with proven and practicable best available technologies and practices. The current regulatory performance target for SBM oil on wet solids prior to discharges defined in the OWTG is less than or equal to 6.9 g / 100 g. Any released SBM and SBM-associated drill cuttings resulting from the Project will not result in adverse effects from contamination of marine biota or habitats, as these materials have low toxicity and localized biological effects (Bakke et al 2013; Deblois et al 2014).

To provide additional, Project-specific information and analysis related to the nature and extent of drilling fluid and associated cuttings disposition resulting from the Project, detailed drill cuttings dispersion modelling has been carried out for this EIS. This included modelling at representative sites within each of the two exploratory license areas (EL 1144 and EL 1150, Figure 8.2) to evaluate the potential dispersion and eventual seabed "footprint" of these cuttings in seasonal scenarios (Amec Foster Wheeler, 2017, see Appendix D).

The example well site locations were selected to represent the potential range of credible drilling scenarios. The criteria used included: reservoir type and properties; administrative boundaries (e.g., licence area boundaries); and the physical environment (e.g., potential range of water depths, proximity to more sensitive areas, potential range of ocean currents). The sites were placed on either side of the Flemish Pass with one example well as deep water and deep reservoir depth and one example well as shallower water and shallower reservoir depth.

The results of this modelling are summarized and utilized here to assess potential biological effects on benthic habitats and biota, particularly the overall habitat alterations that may be associated with this cuttings footprint (including its location, extent, and thickness) and the possible ecological implications of these.

Figure 8.2 Example Wellsite Locations Used in EIS Modelling



EL 1144 Deepwater Jurassic Example Well

EL 1144 is located on the western side of the Project Area and its extent mainly covers the Flemish Pass. The modelled (example) wellsite is located within the Flemish Pass at a water column depth of 1,137 m.

WBM cuttings released two metres above the seafloor are predicted to completely settle within 500 m of the wellsite under all seasonal scenarios. The majority of WBM cuttings (93 to greater than 98 percent) settle within 100 m of the wellsite across seasonal scenarios. The greatest distance the WBM cuttings are predicted to drift range from 210 m in September to 290 m in December. WBM cuttings pile thicknesses are estimated to be greatest near the source and decrease with distance. Within 10 m from the wellsite, average WBM cuttings pile thickness is predicted to range from 0.69-0.79 m with maximum thickness values of 2.71-2.87 m. Assuming slumping of these piles to an angle of repose of 30o, the maximum thicknesses are more likely 0.7 to 1.4 mm. From 10-100 m from the wellsite, average WBM cuttings pile thickness is predicted to range from 18-19 mm and decreases to 1-4 mm beyond 100 m.

SBM cuttings released two metres below the sea surface are predicted to mainly settle (approximately 96 percent) within two kilometers of the wellsite with over 90 percent settling within 500 m. Approximately 3.5 percent of total SBM cuttings that disperse beyond two kilometers settle 25 to 54 km south-southwest from the example wellsite. Predicted SBM cuttings pile thickness also generally decreases with distance with distributional variations dependent on seasonal hydrodynamics. Mean SBM cuttings thicknesses out to 200 m generally range from one to 10 mm. The September scenario is the exception where there is estimated mean SBM cuttings thickness of 37 mm within 10 m of the wellhead resulting from relatively lighter currents. The predicted maximum SBM cuttings thicknesses are 38-48 mm and are located to the south-southwest from the example wellsite at distances of less than 500 m.

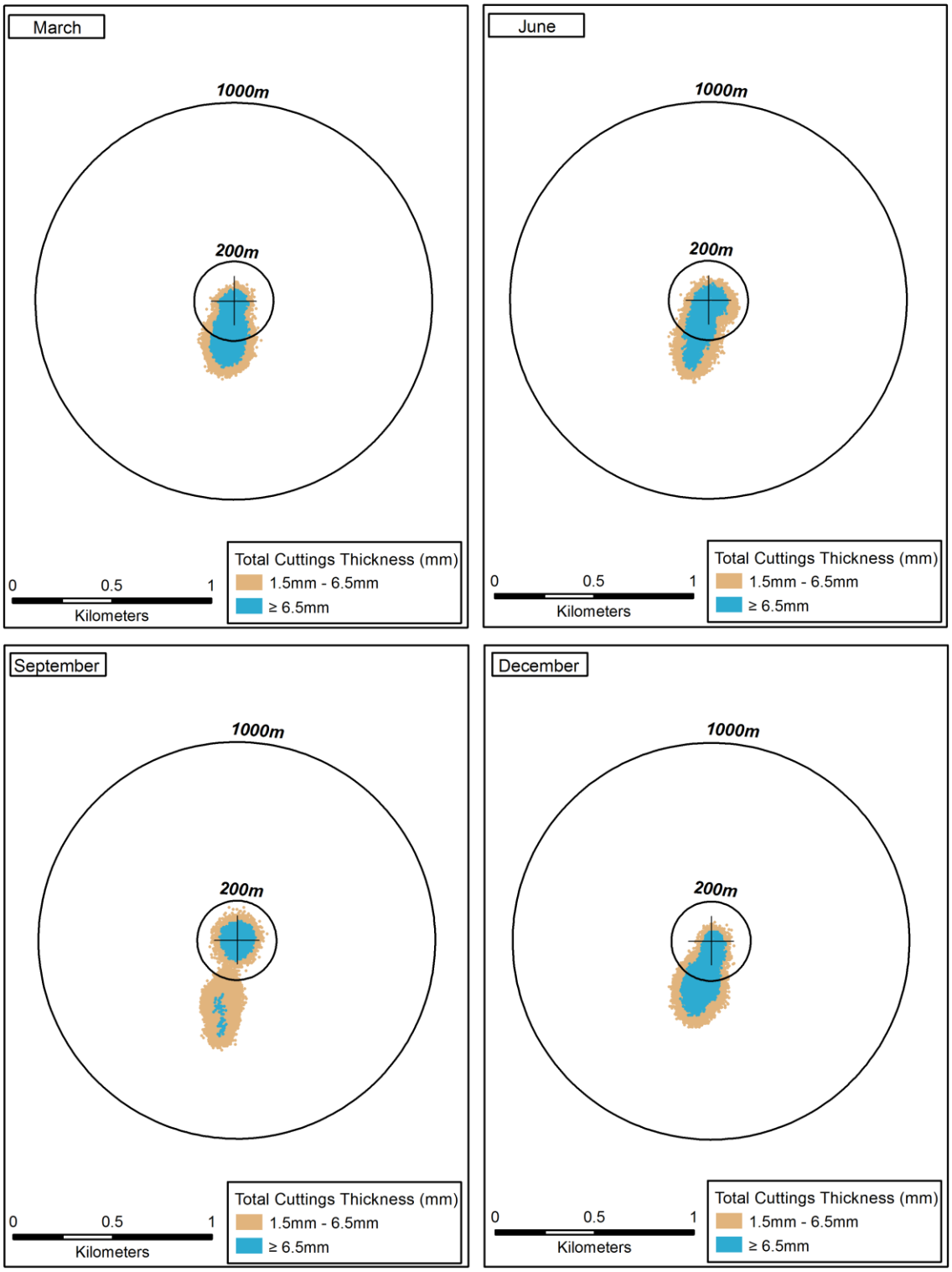
Estimated average areal extent of total cuttings above the conservative 1.5 mm PNET are approximately 154,000 m^2 and oriented to the south-southwest across seasonal scenarios (Figure 8.3). The largest estimated total cuttings area above the 1.5 mm PNET was approximately 182,000 m^2 and predicted to occur in the September scenario. The predicted areas of total cuttings thickness above the 6.5 mm PNET are approximately 60,000 m^2 in March, June and December seasonal scenarios (Figure 8.3). The areal extent is smaller in the September seasonal scenario, about 27,000 m^2, and is symmetrical about the wellhead due to light currents.

Table 8.3 Cuttings Material and Thickness by Distance: EL 1144 Deepwater Jurassic Example Well

Seasonal Scenario	Parameter	0-10 m	10-100 m	100 - 200 m	200-500 m	500 m-1 km	1-2 km	% Material Unsettled
WBM Cuttings								
March (Winter)	Settled (%)	31.7	66.7	1.5	<0.1	-	-	-
	Mean Thickness (mm)	716.0	19.0	1.0	1.0	-	-	-
	Maximum Thickness (mm)	2760.0	257.0	7.0	1.0	-	-	-
June (Spring)	Settled (%)	35.1	63.7	1.2	<0.1	-	-	-
	Mean Thickness (mm)	793.0	18.0	1.0	1.0	-	-	-

Seasonal Scenario	Parameter	0-10 m	10-100 m	100 - 200 m	200-500 m	500 m-1 km	1-2 km	% Material Unsettled
	Maximum Thickness (mm)	2874.0	210.0	5.0	1.0	-	-	-
September (Summer)	Settled (%)	31.5	65.9	2.6	<0.1	-	-	-
	Mean Thickness (mm)	712.0	19.0	2.0	1.0	-	-	-
	Maximum Thickness (mm)	2742.0	244.0	19.0	1.0	-	-	-
December (Fall)	Settled (%)	30.5	62.1	7.4	<0.1	-	-	-
	Mean Thickness (mm)	688.0	19.0	4.0	1.0	-	-	-
	Maximum Thickness (mm)	2709.0	255.0	41.0	1.0	-	-	-
SBM Cuttings								
March (Winter)	Settled (%)	<0.1	4.9	41.1	43.3	6.9	0.2	3.5
	Mean Thickness (mm)	0.4	2.0	8.0	2.0	0.2	0.1	-
	Maximum Thickness (mm)	1.0	24.0	47.0	31.0	1.0	0.2	-
June (Spring)	Settled (%)	0.4	22.5	37.3	32.0	4.0	0.3	3.5
	Mean Thickness (mm)	10.0	6.0	3.0	1.0	0.1	0.1	-
	Maximum Thickness (mm)	12.0	21.0	38.0	22.0	1.0	0.4	-
September (Summer)	Settled (%)	1.6	47.8	8.1	28.9	8.7	1.4	3.5
	Mean Thickness (mm)	37.0	12.0	1.0	1.0	0.2	0.1	-
	Maximum Thickness (mm)	48.0	47.0	7.0	9.0	7.0	0.5	-
December (Fall)	Settled (%)	<0.1	1.1	25.7	61.5	7.7	0.5	3.5
	Mean Thickness (mm)	0.1	1.0	6.0	3.0	0.2	0.1	-
	Maximum Thickness (mm)	0.2	6.0	42.0	42.0	1.0	0.3	-
Note: Thicknesses > 0.5 mm rounded to nearest mm								

Figure 8.3 Total Cuttings Material Above the 1.5 mm and 6.5 mm PNET: EL 1144 Deepwater Jurassic Example Well



EL 1150 Shallow Water Cretaceous Example Well

EL 1150 is located on the eastern side of the Project Area and includes areas of the Flemish Pass and Flemish Cap Shelf and Slopes. The modelled (example) wellsite is on the slope of the Flemish Cap in water depths of 378 m.

Based on the drill cuttings modelling (Appendix D) more than 99 percent of released WBM cuttings are predicted to settle within 200 m of the well site across seasonal scenarios (Table 8.4). The remaining WBM cuttings (less than one percent) are predicted to drift as far as 260 m in March and 240 m during the other months. Average and maximum WBM drill cuttings pile thicknesses are predicted to decrease with distance from the source. Pile thicknesses are greatest within 10 m from the wellsite for all seasons where average and maximum thicknesses ranged from 0.45-0.47 m and 1.76-1.80 m respectively. From 10-100 m from the wellsite, average WBM cuttings pile thickness is predicted to range from 12-13 mm and decreases to 1-4 mm beyond 100 m.

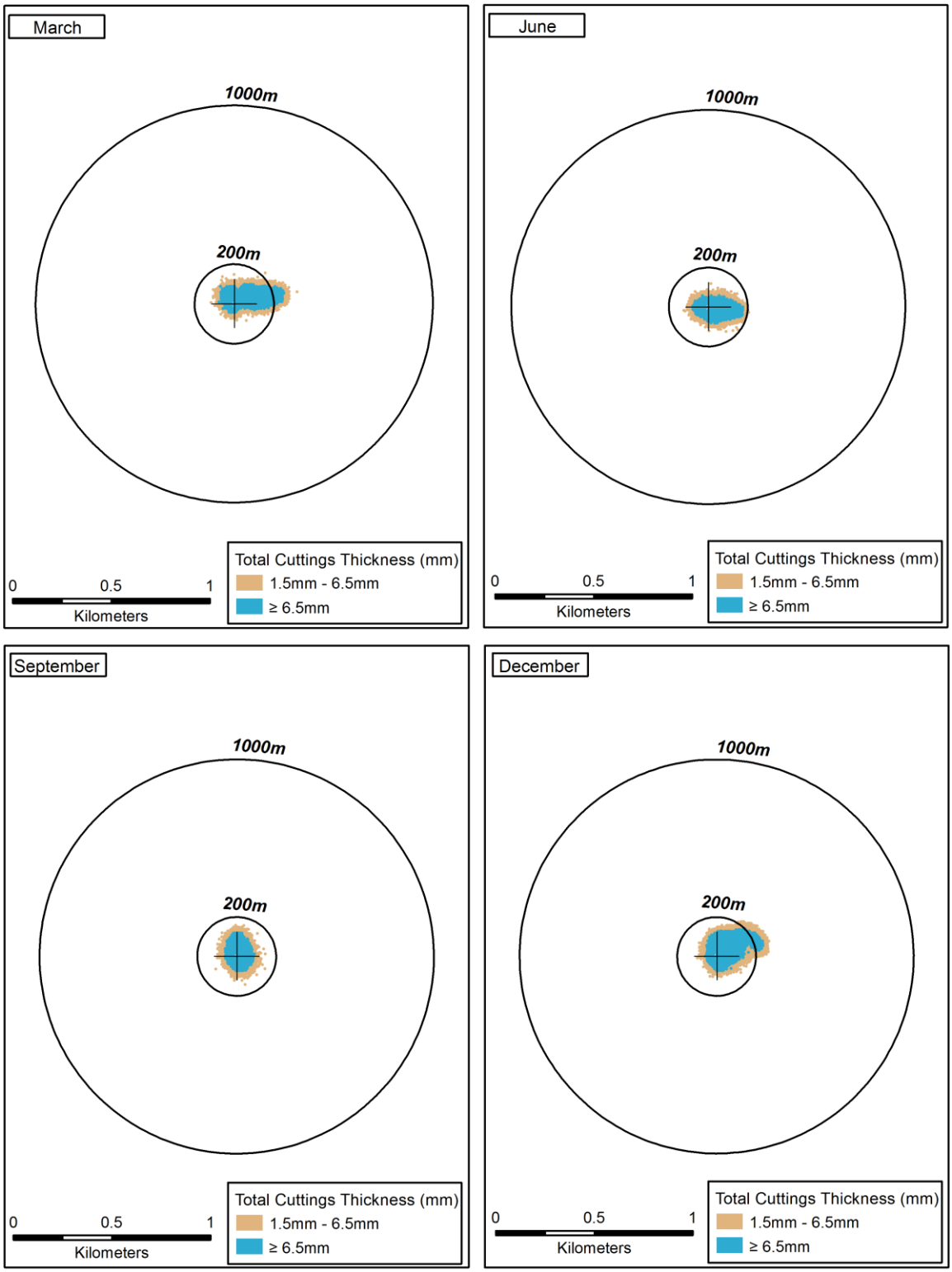
The SBM cuttings released from the MODU settle generally within one kilometer, with over 94 percent settling within 500 m. SBM cuttings thicknesses generally decrease with distance, however as the SBM cuttings are released near the sea surface, they are greatly influenced by seasonal currents. Mean SBM cuttings thicknesses are generally highest out to 100 m and range from 11-15 mm in June, September and December scenarios. In March, relatively larger SBM cuttings thicknesses for the season range from 5-9 mm occur from 10-200 m due to higher currents. The predicted maximum SBM cuttings thicknesses for March, June and September range from 84-99 mm and are located approximately 40-120 m east of the wellsite. For the December scenario, the maximum SBM cuttings thickness is estimated to be 72 mm and is predicted to occur 50 m north of the wellsite. Only 3.6 percent of the total SBM cuttings drift beyond one kilometer with all of these settling with thicknesses less than 0.1 mm. These small amounts of fine sand and silt-sized SBM cuttings are predicted to drift to the northeast from 12-18 km across seasonal scenarios. Predicted average areal extent of total cuttings thickness above the 1.5 mm threshold over the four months is approximately 70,400 m^2 with the areas oriented primarily to the east in March and June, north in September, and northeast in December (Figure 8.4). The largest areal extent above 1.5 mm occurs in December and is predicted to be approximately 84,000 m^2. Average areal extent of total cuttings above the 6.5 mm PNET for all months is approximately 37,500 m^2 with the largest footprint of approximately 46,800 m^2 predicted to occur in December (Figure 8.4).

Table 8.4 Cuttings Material and Thickness by Distance, EL 1150 Shallow Water Cretaceous Example Well

Seasonal Scenario	Parameter	0-10 m	10-100 m	100-200 m	200-500 m	500 m-1 km	1-2 km	% Material Unsettled
WBM Cuttings								
March (Winter)	Settled (%)	30.6	58.4	11.0	0.1	-	-	-
	Mean Thickness (mm)	453.0	12.0	3.0	1.0	-	-	-
	Maximum Thickness (mm)	1756.0	179.0	40.0	1.0	-	-	-
June (Spring)	Settled (%)	30.9	65.5	3.5	<0.1	-	-	-
	Mean Thickness (mm)	458.0	12.0	2.0	1.0	-	-	-
	Maximum Thickness (mm)	1794.0	174.0	15.0	1.0	-	-	-

Seasonal Scenario	Parameter	0-10 m	10-100 m	100-200 m	200-500 m	500 m-1 km	1-2 km	% Material Unsettled
September (Summer)	Settled (%)	31.6	66.7	1.6	<0.1	-	-	-
	Mean Thickness (mm)	468.0	13.0	1.0	1.0	-	-	-
	Maximum Thickness (mm)	1798.0	208.0	5.0	1.0	-	-	-
December (Fall)	Settled (%)	30.7	58.8	10.4	<0.1	-	-	-
	Mean Thickness (mm)	454.0	12.0	4.0	1.0	-	-	-
	Maximum Thickness (mm)	1781.0	175.0	37.0	2.0	-	-	-
SBM Cuttings								
March (Winter)	Settled (%)	<0.1	14.6	56.3	23.1	2.3	-	-
	Mean Thickness (mm)	0.5	5.0	9.0	1.0	0.2	-	-
	Maximum Thickness (mm)	0.9	65.0	87.0	29.0	1.0	-	-
June (Spring)	Settled (%)	1.4	62.4	24.1	8.2	0.4	-	-
	Mean Thickness (mm)	25.0	12.0	2.0	0.3	0.1	-	-
	Maximum Thickness (mm)	35.0	84.0	37.0	7.0	0.5	-	-
September (Summer)	Settled (%)	2.4	76.0	11.6	6.4	0.1	-	-
	Mean Thickness (mm)	43.0	15.0	1.0	0.2	0.1	-	-
	Maximum Thickness (mm)	62.0	99.0	19.0	1.0	0.2	-	-
December (Fall)	Settled (%)	0.7	45.3	28.5	19.3	2.6	-	-
	Mean Thickness (mm)	13.0	11.0	3.0	0.6	0.2	-	-
	Maximum Thickness (mm)	26.0	72.0	28.0	13.0	1.0	-	-
Note: Thicknesses > 0.5 mm rounded to nearest mm								

Figure 8.4 Total Cuttings Material above the 1.5 mm and 6.5 mm PNET: EL 1150 Shallow Water Cretaceous Example Well



Summary of Drill Cuttings Modelling Results and Effects Assessment

The modelling conducted for example wellsites in the Project Area indicate that the WBM and SBM drill cuttings will be highly localized with the majority of materials predicted to settle within 500 m of the well head. Very small quantities (less than four percent) of SBM cuttings are predicted to disperse beyond 1-2 km from the deepwater wellsite with predicted accumulations (less than 0.1 mm) well below the PNET values.

Due to the relatively low quantities, dispersed SBM cuttings are only expected to have very low potential for interactions with organisms in the water column and benthic areas more than 1-2 km from the wellsite. The localized footprint of total settled cuttings coincides with areas exceeding the 1.5 mm and 6.5 mm PNET (Kjeilen-Eilertsen et al 2004; Smit et al 2006; 2008). As the finer SBM cuttings disperse wider than the WBM cuttings, the extent of areas beyond the conservative 1.5 mm PNET is higher than areas beyond the 6.5 mm PNET. As the SBM cuttings released from the surface have a wider dispersion pattern in deeper waters, predicted total cuttings areas beyond the 1.5 mm PNET is higher at EL 1144 (average: 154,000 m^2) than EL 1150 (average: 70,400 m^2). Similarly, total cuttings areas beyond the 6.5 mm PNET are largely within 200 m of the shallow water EL 1150 example wellsite and within 500 m of the deep water EL 1144 example wellsite. While there are areas beyond the PNET values, their relative footprints are small with potential for eventual recovery. A deep-water drilling site (380 m depth) in the Faroe-Shetland Channel produced similar project footprints with 30,700 m^2 covered completely by cuttings and greater than 70,890 m^2 partially covered by cuttings (Jones et al 2012). Environmental monitoring of the site showed relatively higher faunal density and richness three and 10 years from the initial disturbance indicating recovery of the site over time (Jones et al 2012). Localized accumulations indicates that potential burial effects are relatively low spatially and presence of surrounding undisturbed areas may further promote recolonization and recovery.

For this Project, a somewhat higher potential for interactions with habitat forming coral and sponge species exists in areas such as the slopes of the Newfoundland Shelf, Flemish Pass and Flemish Cap which are more likely to have higher densities of coral and sponge species as compared to other parts of the Project Area / LSA and the Eastern Newfoundland Offshore Area in general (Section 6.1.6). As described in Section 8.3.2, prior to the start of drilling activity at a wellsite, a seabed investigation will be undertaken with an underwater video system to investigate the potential presence of aggregations of sensitive benthic organisms or habitats in the immediate area (such as corals gardens and sponge grounds). Should such organisms be observed within or in proximity to a planned wellsite location, Nexen will move the wellsite where possible to avoid or reduce the potential for direct interaction with them or other potential effects (such as sedimentation or burial from drill cuttings disposal). In addition, the likely distance between individual wells that will be drilled as part of this Project means that there is also little or no potential for these environmental releases from individual wells to interact or accumulate in the LSA.

The initial high settling of particles and relatively low quantities of dispersed cuttings beyond two kilometres also indicates that there will not be any substantial interaction with pelagic species. The Project Area depths are also beyond the photic zone and it is therefore also not expected that there will be any interaction with marine macroflora species. Discharge of drill cuttings particles may form aggregates with phytoplankton resulting in rapid settling of plankton to the seafloor (Pabortsava et al 2011). However, due to the low quantities, it is unlikely that there will be high settling or turbidity effects that may adversely affect any suspended phytoplankton species.

In summary, therefore, discharged volumes of WBM and SBM drill cuttings will be highly localized to the wellsite with very low quantities dispersing widely. The predicted small footprint limits smothering effects on benthic species to less than 500 m around the wellsite. The remaining low quantities of cuttings dispersed beyond two kilometers are not predicted to have any potential interactions due to the expected low concentration in the water column and lack of accumulation on the seabed. Released SBM associated drill cuttings will be treated in accordance with the OWTG to minimize any toxic and bioaccumulation effects.

This planned Project activity is predicted to have adverse but low magnitude effects, which will be primarily localized but occurring within the LSA overall, medium to long-term duration and continuous in nature during drilling, all of which will be reversible with eventual recovery and recolonization of the area. These predictions are made with a high level of certainty.

8.3.5 Vertical Seismic Profiling

The Project will also include VSP surveys, which are used in interpreting the results of oil and gas exploration drilling activities through the correlation of time-based depth information from 3D seismic data to the actual drilling depth. VSP enables the acquisition of time, depth, and velocity information for the formations in which drilling has been completed, with a number of techniques being available for acquiring VSP data. In the marine environment, receivers are typically placed in the borehole and a sound source is deployed, usually from the drilling platform crane into the water column at a predetermined depth (approximately 5-20 m) to achieve a near zero offset. Walk-away VSP surveys may also be undertaken, which involve placing a sound source on a vessel which then moves away while activating the seismic source at pre-determined distances from the borehole receiver.

8.3.5.1 Overview of Potential Effects and Existing Knowledge

Overall potential effects of VSP are derived mainly from research on seismic surveys. Although VSP activities typically use smaller sound sources and are much shorter in duration in comparison to offshore oil and gas seismic surveys, the following provides a summary of the available scientific literature related to the overall potential effects on marine organisms from seismic activities.

Potential Mortality or Injury

A variety of studies have investigated potential injury to fish as a result of seismic sound source arrays, such as damage to hearing structures (e.g. Popper et al 2005; Popper and Hastings 2009; Popper and Fay 2011; Carroll et al 2017) and/or mortality of fish, fish eggs or larvae (e.g. Parry and Gason 2006). Most studies have found that stationary fish affected by seismic surveys had to be located very close to the seismic array (usually caged close to the source and subjected to multiple passes of the array) to be affected (see McCauley et al 2003 and Turnpenny and Nedwell 1994 for a review). Studies using caged fish have also noted that the response of the fish is usually a strong attempt to move away from the sound (e.g. McCauley et al 2003).

Due to the spectrum of hearing capabilities of fish and invertebrates (see below), seismic noise activities may have varying effects (Popper and Hastings 2009; Popper and Fay 2011). In some species, seismic activities have been shown to cause a temporary threshold shift (TTS) in hearing sensitivity (Popper et al 2005; Popper and Hastings 2009; Carroll et al 2017) which may result in reduced abilities for

communications, predator or prey detection, and assessing the environment (Carroll et al 2017). There is little information on permanent threshold shifts (PTS) in fish hearing. In one experiment, multiple exposures of sound emissions (source level at 1 m of 222.6 dB re 1 µPA peak to peak, or 203.6 dB re 1 µPA mean squared pressure) damaged hearing sensory structures in pink snapper with no recovery 58 days after exposure (McCauley et al 2003). However, this type of seismic air gun injury to fish has not be observed in other species (Popper et al 2005; Song et al 2008). The effects of seismic surveys on marine phytoplankton, zooplankton and the planktonic life stages of various marine fish species have also been investigated (see, for example, Dalen et al 2007 for a review). Mortality or sublethal effects on fish, fish eggs, and larvae have mainly been observed only within a few metres of seismic sound source arrays (Kostyuchenko 1973; Dalen and Knutsen 1987; Matishov 1992; Kosheleva 1992; Holiday et al in Turnpenny and Nedwell 1994; Parry and Gason 2006; Payne et al 2009). Some species may also become habituated to underwater noise levels (Popper and Hastings 2009, Carroll et al 2017). Seismic noise and associated pressure waves have been shown to have lethal or sublethal effects on larval and adult plankton at short range of less than 5 m (Østby et al 2003, in Boertmann and Mosbech 2011) to up to 1.2 km away from the air gun array (McCauley et al 2017). Davis et al (1998) estimated that up to one percent of the ichthyoplankton in the top 50 m of the water column within close proximity (1.5-3.0 m) to the sound source could be killed during 3D seismic surveys off Nova Scotia. Kenchington (1999) also estimated a plankton mortality rate to potentially increase to 12 percent if they were concentrated in the upper 10 m, centered on the depth of the air gun array, as a “worst case” scenario. In Norway, it was estimated that 0.45 percent of planktonic organisms within 10 m of the air gun could be killed by seismic noise with a lethal radius of 2 m (Sætre and Ona 1996). Mortality of fish eggs, caused by exposure to seismic array noise, was predicted to be very low compared to natural mortality and was considered not significant to fish recruitment (Sætre and Ona 1996, in Popper et al 2014).

Payne et al (2008) indicated that there was no evidence of delayed mortality or egg loss in snow crab exposed under the conditions of an actual seismic program in deep waters off Cape Breton. In snow crab, over a period of days to several months, there were no observed effects of delayed mortality or damage to mechano-sensory systems associated with animal equilibrium and posture. There was also no evidence of leg loss or other appendages (Payne et al 2008). A snow crab test group exposed to seismic sound showed elevated bruising of the hepatopancreas, bruising of ovaries, and dilated oocytes with detached chorions (DFO 2004). The timing and location of seismic activity and proximity to the array is a key factor in the likelihood and potential degree of the effect. Christian et al (2003, 2004) also did not observe any acute or chronic mortality in adult snow crab experimentally exposed to variable seismic sound levels, although a higher proportion of less developed eggs was noted for experimentally exposed egg masses in comparison to unexposed egg masses. Seismic sound source arrays operating in areas and times of strong seasonal stratifications or upwelling may affect more planktonic material because of their high densities (Boudreau et al 2001). Although it is recognized that marine invertebrates (including juvenile stages) can be quite sensitive to sound (Williams et al 2015; Edmonds et al 2016; Kunc et al 2016; Nedelec et al 2016), recent field-based studies on adult populations revealed no evidence of increased mortality due to exposure in scallops up to ten months after exposure, clams after two days after exposure, or lobsters up to eight months after exposure (Carroll et al 2017).

Although it is evident that fish often respond to sounds emitted from seismic sound source arrays (see below), little direct physical damage to fish occurs at distances greater than a few meters from the source. Due to the avoidance behaviour by free-swimming fish, they typically do not suffer physical damage from seismic surveys (Gausland 1993). Indeed, there are no documented cases of fish

mortality under exposure to seismic sound under field operating conditions (DFO 2004; Payne 2004; Popper et al 2014; Carroll et al 2017), nor have seismic ship personnel reported observing dead fish around survey operations. Overall, exposure to seismic sound is considered unlikely to result in direct fish mortality (DFO 2004). It has been noted, however, that non-injurious (behavioural) effects can still be of concern if they accumulate to have population-level implications (Williams et al 2015).

Behavioural Responses

When exposed to an operating seismic array, mobile marine fish may exhibit a variety of responses, including alarm responses and temporary avoidance of the area (e.g., McCauley et al 2000a, 2000b). When exposed to operating seismic sound source arrays, mobile marine fish may swim deeper, mill in compact schools or become more active (e.g., Slotte et al 2004). Indeed, behavioural reactions to exposure to seismic noise have been widely documented in marine organisms (Popper and Hastings 2009; Slabbekoorn et al 2010; Hawkins et al 2015; Carroll et al 2017). There are well documented observations of fish and invertebrates exhibiting behaviours that appeared to be in response to exposure to active seismic sound source array noise levels. These include startle responses, changes in swimming direction and speed, or changes in vertical distribution (Blaxter et al 1981; Schwartz and Greer 1984; Pearson et al 1994; McCauley et al 2000a, 2000b; Wardle et al 2001; Hassel et al 2003; Samson et al 2014; Solan et al 2016). Gadoids (cod species), for example, have been shown to leave the area during seismic surveys (Skalski et al 1992, Løkkeborg and Soldal 1993, Engås et al 1996, Slotte et al 2004, Parry and Gason 2006). Species such as cod, herring, redfish and whiting have been reported to change depth in response to seismic noise (Skalsi et al 1992; Pearson et al 1994; Wardle et al 2001; Slotte et al 2004).

Other studies have found that many species of fish dive to avoid intense sound (Protasov 1966; Schwartz and Greer 1984; Knudsen et al 1992). McCauley et al (2000a, 2000b) describes a more intense “generic” fish alarm startle response of seeking shelter in tight schools and moving near the bottom. Anthropogenic noise appears to have a more pronounced effect on larger fish (Engås et al 1996) and invertebrates (Wale et al 2013a, 2013b) than smaller individuals. In contrast, other studies indicate that fish do not change behaviour when exposed to an active seismic sound source array (e.g., Pickett et al 1994; Wardle et al 2001; Andriguetto-Filho et al 2005). Wardle et al (2001), for example, report that neither finfish nor invertebrates showed signs of moving away from a reef on the west coast of Scotland after four days of seismic sound source array activation. Similarly, Peña et al (2013) indicated that feeding herring were undeterred by seismic activity as they approached to within two kilometers of seismic survey operations. Marine benthic invertebrates exposed to seismic sounds have been observed to respond to seismic noise with startle or stress behaviours (Solan et al 2016), but often do not necessarily undergo avoidance behaviours (Carroll et al 2017). However, stress behaviours in invertebrates may eventually weaken individuals with chronic exposure to seismic activities (Solan et al 2016). Snow crab located 50 m from a seismic source did not exhibit alarm responses or changes in physiology (Christian et al 2004). There was no evidence of effects on snow crab egg hatch time although the proportion of less developed eggs were higher in exposed egg masses (Christian et al 2003, 2004; Payne et al 2008). Seemingly similar species respond differently to the same anthropogenic noise source due to the range of hearing capabilities and sensitivities (Hawkins and Popper 2014) and responses can differ within a species depending on the time of day and other factors.

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Radford et al (2014) recently reviewed the effects of anthropogenic noise on fish communication. They highlight that communication plays an important role in the ecology of many fish (e.g. territorial disputes,

mating, predatory attacks, aggregating for spawning) and masking these sounds could affect survival and reproductive success. Furthermore, non-masking sounds have the potential to stress fish and/or reduce performance of many activities. These authors and others (e.g. Hawkins et al 2015) emphasize that there remains relatively little empirical data regarding seismic effects on fish, particularly given the vast number of species involved and that such effects vary across fish taxa, based on their physiology, ecology and adaptation (Radford et al 2014; Carroll et al 2017).

Some studies indicate that any behavioural changes that do occur are very temporary while others imply that marine animals might not resume pre-seismic behaviours or distributions for several days (Engås et al 1996; Løkkeborg 1991; Skalski et al 1992; Hassel et al 2003; Solan et al 2016). Most available literature (Blaxter et al 1981; Dalen and Raknes 1985; Davis et al 1998; McCauley et al 2000a, 2000b) indicates that the effects of noise on fish are brief and if the effects are short-lived and outside a critical period, they are expected not to translate into biological or physical effects. The understanding of anthropogenic noise effects on fish and invertebrates remains incomplete (Slabbekoorn et al 2010; Popper and Hastings 2009; Hawkins et al 2015).

Observed Effects on Fish Presence (Including Fishing Activity)

The potential behavioural effects of seismic activities as described above may result in associated changes in overall fish distribution within the affected area. A number of studies have documented changes in fishing success rates during and following nearby seismic survey activity. Skalski et al (1992), for example, cite seismic activity as a contributing factor for decreased redfish abundance, and Løkkeborg (1991) observed reduced catches in fish for days following 2D/3D seismic survey exposure as a result of changes in fish behaviour. Similarly, reduced catches of haddock and Atlantic cod within several kilometres of seismic activity continued for days after seismic activity stopped (Engås et al 1996; Engås and Løkkeborg 2002). Catches for some species/gear types (such as gillnet catches of orange rockfish and halibut) have actually increased during seismic activity, whereas others (such as longline catches of haddock) have been observed to decrease. At larger scales, regions with seismic survey activity had decreased catches for only a few species for certain gear types (e.g., saithe and haddock with gill nets; Vold et al 2009). There also has been evidence of increased catch rates of fish 30-50 km away from seismic activities indicating avoidance by migrating fish (Popper and Hastings 2009). Seismic noise effects have not been demonstrated on catch rates of Australian rock lobster, snow crab, lobster, shrimp and some reef invertebrates (Carroll et al 2017).

A desktop study of four species (gummy shark, tiger flathead, silver warehou, school whiting) in Bass Strait, Australia, found no consistent relationships between catch rates and seismic survey activity in the area, although the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded (Thomson et al 2014). A subsequent desktop study targeting a single seismic survey found that of the 15 commercial species examined, six species showed higher catch following the survey, three species showed reduced catch, and five species showed no change (Przeslawski et al 2015). In Newfoundland waters, anecdotal information from fishers indicated reduced catch rates of snow crab were observed after a pass by seismic survey vessels (Christian and Bocking 2013). Fishers also observed temporary avoidance to deeper waters by a school of shrimp in response to a seismic sound source (Christian and Bocking 2013). The potential effects of seismic survey activity on fish catch rates therefore appear to vary by species and gear type (Hirst and Rodhouse 2000; Løkkeborg et al 2012; Worcester 2006; Vold et al 2012). More locally, fishers that

utilize the Eastern Newfoundland Offshore Area have also expressed concern that seismic survey activity may affect catch rates and the results of research surveys (Amec 2014).

Sound Levels That May Affect Fish and Invertebrates (Physical or Behavioural)

Studies of fish reactions to anthropogenic noise in the marine environment have produced a range of results across different sound levels and between species. For context, container shipping and oil platform production can reach levels of 198 dB (Ross 1976). Subtle behavioural changes of rockfish exposed to seismic sounds, for example, commenced at 149 dB and alarm response became significant at 168 dB (Pearson et al 1994). Eastern striped grunter displayed persistent C-turn startle responses at 182 – 195 dB (McCauley et al 2000a, 2000b), whereas various fish showed startle responses to noises ranging from 183 - 207dB (Wardle et al 2001). The onset of 'alarm' behaviours typically begin at 156 – 161 dB (McCauley et al 2000a, 2000b). Blaxter et al (1981) found that schooling herring changed direction with a sudden noise level of 144 dB re 1 µPa. Løkkeborg and Soldal (1993) estimated that avoidance behaviour in fish occurs between 160 and 171 dB re 1 µPa. Engås et al (1996) noted that mild behavioural effects can extend to tens of kilometres from the seismic source. This is supported by DNV Energy (2007, in Hurley 2009) which states that scare effects have been demonstrated in a radius of more than 30 km from the seismic sound source. Sound exposure guidelines for fish (Popper et al 2014) in relation to seismic activities indicate that TTS may occur at over 186 db SEL and potential mortal injuries may occur at greater than 207 db SEL.

As with fish, some invertebrates may become habituated to sound, with squid showing fewer alarm responses with subsequent exposure to noise from sound source arrays, cuttlefish habituating to repeated 200 Hz tone pips (Samson et al 2014), and squid showing decreased responses over sound exposure trials (Mooney et al 2016). There is also some indication of habituation in crabs to vibrations (Roberts et al 2016).

Some select examples of previous studies which have investigated physical and physiological damage to fish as a result of exposure to different levels of seismic sound are provided below. It is noteworthy that many of these studies were conducted in the laboratory and therefore may not always reflect effects experienced by free ranging organisms in the wild:

- In comparison to controls, there were no mortalities one to four days post exposure to seismic sound source arrays in monkfish larvae (205 dB re 1 µPa) and capelin eggs (199 dB re 1 µPa) (Payne et al 2009).

- Cod eggs exposed to seismic shots (202 – 220 dB) showed no signs of injury (Dalen and Knutsen 1987).

- Cod larvae (220 dB) and fry (234 dB) were shown to experience immediate mortality, but eggs showed no signs of injury (Dalen and Knutsen 1987)

- No injury to red mullet eggs occurred at 210 dB but eight percent were injured at 230 dB (Kostyuchenko 1973).

- Kostyuchenko (1973) reported more than 75 percent survival of fish eggs at 0.5 m from the source (233 dB at 1 m) and more than 90 percent survival at 10 m from the source.

- Pollock eggs (242 dB) have been observed to show delayed mortality (Booman et al 1996).

- Swimbladders of anchovy larvae were ruptured at 238 dB (Holiday et al, in Turnpenny and Nedwell 1994).

- Matishov (1992) showed that five day old cod experienced delimitation of retina at 250 dB.

- Caged freshwater pallid sturgeon and paddlefish that were exposed to a single pulse from a small seismic sound source array (10,160 cm^3) showed no mortality or mortal injury either immediately or within seven days of exposure (Popper et al 2016, Carroll et al 2017).

- European seabass exposed to playbacks of pile-driving or seismic noise for 12 weeks no longer responded with an elevated ventilation rate to the same noise type, and showed no differences in stress, growth or mortality compared to those reared with exposure to ambient-noise playback (Radford et al 2016).

- Popper et al (2005) reported exposure to seismic sound source arrays (186 dB re 1 µPa2s-1) resulted hearing TTS in freshwater lake chub and northern pike with recovery within 18-24 hours. In the same study, no effects were observed on broad whitefish, another freshwater species.

- Hastings (1990) reported that lethal threshold for fish occurs at 229 dB and a stunning effect in the 192 to 198 dB range.

- Caged pink snapper had extensive sensory hair damage with no recovery or repair 58 days after exposure in response to peak seismic sound levels of 165-209 dB re 1 µPa (McCauley et al 2003).

- Kosheleva (1992) reported no obvious physiological effects of fish beyond 1 m from a source of 220 to 240 dB.

- Brown shrimp exposed to 190 dB showed no injury (Webb and Kempf 1998).

- There were no acute or chronic mortalities 12 weeks after exposure in captive adult snow crab associated with variable seismic noise (sound peak levels (SPL) 191-221 dB re 1 µPa0-p, and sound energy levels (SEL) <130-187 dB re µPa2s-1) (Christian et al 2003, 2004).

- At 217 dB, Matishov (1992) observed shell damage in Iceland scallops while urchins lost 15 percent of their spines.

- No detectable differences were observed in mussels, crustaceans or periwinkles within 30 days after exposure to 229 dB seismic arrays (Kosheleva 1992).

- At 231 dB, Dungeness crab larvae molt times and long term survival were not affected (Pearson et al 1994).

In recent research, Hawkins et al (2014) studied the response of mackerel and sprat schools to repeated impulsive sounds. Incidence of response increased with sound levels but responses were different across species (mackerel changed depth while sprat dispersed). The sound level where 50 percent of fish schools responded was 163.2 and 163.3 dB re 1mPa2 (peak to peak) and 135 and 142 dB re 1mPa2 for single strike for sprat and mackerel, respectively.

Popper et al (2014) established sound exposure guidelines for seismic activities for fishes with and without swim bladders. It was estimated that potential hearing TTS would occur at 186 dB SEL and recoverable injuries would occur at 203- 216 dB SEL or 207-213 dB SPL. Mortality or potential mortal injury sound exposure guidelines ranged from 207-219 dB SEL and 207-213 dB SPL.

Detection Ability of Fish and Invertebrates

Many fish species and invertebrates are capable of emitting noise that share frequencies with those of seismic noise (Myrberg 1980; Turnpenny and Nedwell 1994; Engen and Folstad 1999; Hawkins and Amorin 2000; Slabbekoorn et al 2010). Some species use acoustic communication during reproduction and predator interactions (Slabbekoorn et al 2010). Some fish are also able to distinguish and interpret competing sounds (MMS 2004).

Fish can be categorized based on their hearing capability and method of transmission for particle motion and sound pressure detection (Popper et al 2014). Fish with no swim bladder including sharks and flatfish hear through direct sound transmission to the otolith and sensory hairs, restricting detection to the particle motion component of sound. The swim bladder is a gas filled structure that may contract or expand relative to the rest of the fish in a sound field (Christian and Bocking 2013). Fish with swim bladders not associated with hearing, including Atlantic cod and Atlantic salmon, also detect the particle motion component of sound but may be susceptible to barotrauma (Carroll et al 2017). Fishes with connections between the inner ear and the swim bladder include squirrel fish, mormyrids and herring. These fish have increased hearing sensitivity and may be more susceptible to sound pressure (Christian and Bocking 2013; Carroll et al 2017).

Marine invertebrates typically lack organs that detect pressure waves but some species (e.g. marine crabs, squid, and echinoderms) have statocysts that are capable of sound detection through particle motion (Popper et al 2001; Morley et al 2014). Cephalopods (squid) and decapod crustaceans have sensory hairs that also aid in particle motion detection (Carroll et al 2017). Organisms that rely exclusively on particle motion (as in most invertebrates) to detect sound are more resilient to anthropogenic noise exposure (Morley et al 2014). Laboratory studies show that some crustaceans (e.g. Norway lobster) will respond to sounds that are within the frequency range of that used in seismic surveys (Goodall et al 1990).

Hearing sensitivities of finfish are reviewed by Popper and Carlson (1998) and Popper et al (2003). Cod, salmon, America plaice and herring have hearing sensitivity between 80 and 200 Hz, with a sensitivity threshold at 80 to 100 dB re to 1µPa (Mitson 1995). Deep water species and those lacking swim bladders may be less vulnerable to effects from seismic survey activities (Boertmann and Mosbech 2011). Larger fish are also potentially more susceptible to injury than smaller fish resulting from differences in swim bladder resonance (Carroll et al 2017).

8.3.5.2 Residual Environmental Effects Assessment

VSP acquisition surveys are typically short-term activities of one to two days duration, with seismic source activation often limited to just a few hours. The VSP array and its sound emissions are also typically smaller and more localized than that used in larger offshore seismic (geophysical) surveys (such as those whose effects have been studied through the literature summarized above), with the majority of sound directed downwards into the well and a lesser degree directed horizontally. Appendix E provides an analysis of the underwater sound that will be generated by the VSP surveys such as those that may be generated as part of this Project.

Operational procedures, such as the use of a gradual “ramp-up” or soft-start procedure over a minimum period allows mobile marine fish and invertebrates to move away from the area if they are disturbed by the underwater sound levels associated with the survey, will be implemented for this Project. This will help to further reduce the potential for fish injury or morality, as well as reduce any startle effects (Popper and Hastings 2009) and resulting stress on fish in the nearby area. These, along with the relatively short-term nature of any required use of seismic sound as part of the Project, will reduce any potential for fish injury or morality. Although there may be some short-term behavioural effects to individual fish in the immediate vicinity of the survey activity, it is very unlikely that any fish will be displaced from key habitats or disrupted during key activities over extended areas or periods, or be otherwise affected in a manner that causes negative and detectable effects to fish populations in the region.

Potential effects from VSP activities are therefore predicted to be adverse but low in magnitude, occurring within the LSA, short term in nature, occurring sporadically and reversible, with these predictions being made with a high level of certainty.

8.3.6 Well Testing

If there is sufficient indication of hydrocarbon presence during the exploration drilling program, well flow testing may also be undertaken to sample and identify formation fluids (which may contain hydrocarbons and/or water) and to measure flow rates. A well test program will consist of a variety of activities, including periods where the well is flowed and also where it is shut in. During flow periods, produced hydrocarbons are separated from any produced water on the MODU and analyzed. Small quantities of resulting produced water are sent to the MODU’s flare and may last for one to three days per period. Any larger quantities are treated for disposal to the ocean in compliance with the OWTG. The duration of the well testing process is dependent upon the complexity of the subsurface rock formations, and if encountered, the potential for establishing the extent of hydrocarbon reservoir. Over a one month well test program, approximately 7 to 14 days will involve flowing and shutting in the well, collecting data throughout these periods. Flaring may be required during the series of flow periods which could last 1 to 3 days per period. Testing of multiple targets is also possible, each requiring a separate well test, possibly taking as long as 3 months to execute the entire program. As part of this Project, flaring activities will only be carried out if a drill stem test is required.

8.3.6.1 Overview of Potential Effects and Existing Knowledge

Flaring during well testing and evaluation activities can introduce artificial lighting in offshore environments and that may result in the attraction of certain fish species and affect diel migrations of

fish and plankton (Cordes et al 2016). The artificial light may also attract seabirds (Weise et al 2001) that feed on aggregated fish (Chapter 9).

Any larger volumes of produced water quantities that cannot be flared may be treated and discharged from the MODU into the marine environment. The main contaminants within such produced water include aromatic hydrocarbons, polycyclic aromatic hydrocarbons and related heterocyclic aromatic compounds (Bakke et al 2013), as well as thermal emissions as produced water discharges may be higher in temperature than receiving waters (Teixeira et al 2009). Fish and invertebrates exposed to produced water in laboratories have been observed to exhibit physiological and development effects. However, because the produced water rapidly dilutes, these potential effects are typically limited to within less than one kilometer from the source (Bakke et al 2013). Although produced water typically accounts for one of the largest waste volumes from offshore oil and gas producing operations (Neff 2002), produced water amounts from exploration drilling programs are typically quite small (Morandin and O'Hara 2016).

8.3.6.2 Residual Environmental Effects Assessment

Formation fluid flaring would be run 24 hours a day in duration and lasting one to three days per flow period. This activity is short term in comparison to deck and navigation lighting used consistently for the duration of the program as required for maritime and crew safety. Therefore, light emissions for formation fluid flaring are considered low, and are unlikely to adversely affect fish and fish habitat in the area. Atmospheric emissions may be released as a result of the well flow testing with overall low effects due to the infrequent and short time periods for flaring and will adhere to relevant legislation and regulations discussed in Chapter 2. Any produced water to be discharged will be treated in accordance with the OWTG prior to discharge. As any such emissions will become rapidly diluted, and because fish, invertebrate, and plankton communities typically have a much wider range than the potentially affected area, regional adverse effects on fish and fish habitat are not anticipated.

Potential effects to this VC as a result of well testing are therefore predicted to be adverse but low in magnitude, localized in extent, short term in nature, occurring sporadically and reversible, with these predictions being made with a high level of certainty.

8.3.7 Well Abandonment or Suspension

Once drilling and any associated well testing is completed, the offshore wells drilled as part of this Project will be abandoned. The final well abandonment has not been finalized but will adhere to the requirements set out under the Newfoundland Offshore Petroleum Drilling and Production Regulations SOR/2009-316 and also Nexen's internal governance. Abandonment or suspension involves the isolation of the well bore by placing cement plugs, potentially in combination with mechanical devices, at various depths. If removal of the equipment extending above the mudline is required, the casing will be cut just below the mudline and upper sections of casing and the wellhead will be lifted to surface. This may be done immediately after the well is drilled and evaluated using the MODU or sometime after the well is suspended using a supply vessel. Alternatively, approval may be sought to leave the wellhead in place on the seabed. In this case, the wellhead position would be reported with Canadian Hydrographic Services so nautical charts can be updated. A ROV or other equipment is then used to monitor and inspect the condition of the wellsite in accordance with applicable regulatory requirements at the time of their abandonment or suspension. In certain circumstances, the wells may be suspended

in accordance with C NLOPB requirements for future re-entry. This is similar to the abandonment process described above, but the wellhead is not removed and a suspension cap is installed to protect the wellhead connector.

8.3.7.1 Overview of Potential Effects and Existing Knowledge

Potential effects from well abandonment or suspension include noise and light emissions from activities associated with cement plug or mechanical device installation, wellhead cutting, and pipe movement / fluid circulation. Shelf fishes potentially present during this activity at shallow depths (less than 500 m) include redfish, halibut, cod and capelin, each of which are highly mobile and would likely temporarily avoid any areas of noise disturbances (Popper and Hastings 2009). Deep sea fishes with varying light and noise sensitivities have a range of responses to remote operated vehicles (ROVs) such as those that are typically used throughout offshore drilling programs, including avoidance, aggregation or no reaction (Uiblein 2011). Deep sea fishes present during wellhead removal at depths more than 500 m may be particularly photosensitive to artificial lights from the ROV have been observed to avoid areas of illumination within their light detection range reducing any potential effects (Raymond and Widder 2007). Cutting of the wellhead and use of the ROV thrusters may produce some noise emissions that will result in temporary avoidance of the area by noise-sensitive fish occurring on or close to the seabed (Uiblein 2011; Cordes et al 2016).

Wellhead structures remaining after abandonment or suspension activities may provide increased habitat structure in a relatively barren and soft bottom habitat (Sink et al 2010; Gates et al 2016). Deep sea habitats are generally limited by available hard substrates for corals and sponges to colonize and wellhead structures may create new or enhanced habitat for some species (Sammarco et al 2004; Cordes et al 2016). This process may promote further recovery of the area, although on relatively long time scales due to the long-lived and slow-growing nature of cold-water deep-sea species (Clark et al 2016; Cordes et al 2016) and given the small footprint of subsea infrastructure.

8.3.7.2 Residual Environmental Effects Assessment

Well abandonment or suspension activities will be conducted by installation of a cement plug, and/or mechanical devices and then cutting of the wellhead if required. Blasting is not considered a well abandonment option for environmental and safety reasons. Plug installation and wellhead cutting may result in short term (measured in hours), low magnitude emissions of noise and light that would be no more than regular drilling operations. Fish may temporarily avoid or remain in the area during activities depending on species specific sensitivities to these light and noise emissions. If, in some cases, approval is sought and received to leave the wellhead in place on the seabed, the remaining seabed infrastructure in deeper parts of the Project Area may add small quantities of habitat heterogeneity to the barren environment and potentially aid in recolonization of benthic species and overall recovery.

Potential effects from well abandonment or suspension are therefore predicted to be adverse overall but negligible to low in magnitude, localized, short term in nature, occurring sporadically, and reversible, predicted with a high level of certainty.

8.3.8 Supply and Servicing

The Project will involve vessel and aircraft use (presence and movements), including supply traffic to, from and within the Project Area at all times of year throughout the Project duration. A stand-by vessel will also attend to the MODU throughout the drilling program. It is expected that offshore supply vessel and aircraft (helicopter) services for the Project will be based in St. John's, NL.

8.3.8.1 Overview of Potential Effects and Existing Knowledge

Noise generated by vessel traffic can be transmitted through water (Hildebrand 2009), and may cause avoidance or attraction by some species (Røstad et al 2006; De Robertis and Handegard 2013). Noise from marine activities has been shown to mask the acoustic sensory environment of fish and invertebrates and affect behaviour (Slabbekoorn et al 2010, Wale et al 2013a, 2013b; Morley et al 2014), and may result in fish and invertebrate aggregation or avoidance, communications masking, and other alterations in behaviour (Popper and Hastings 2009; Slabbekoorn et al 2010; Popper et al 2014; Carroll et al 2017), with short term and low frequency noises appearing to elicit temporary avoidance due to startling effects with longer-term avoidance if the noise is of higher frequency or continuous (Misund et al 1996; Wilson and Dill 2002). Physiological and reproductive effects have been reported when fish are continually exposed to noise (Clark et al 2016). The effects of anthropogenic noise in the marine environment can be short-lived, however, and the reduction or removal of noise sources may decrease the potential for any direct, detrimental effects (Williams et al 2015). Indeed, vessel noise effects are temporary, transient, and are generally limited to the duration of the noise emissions or within days afterwards (Popper and Hastings 2009).

Lighting is required for safety of marine personnel during supply vessel operations and will likely be emitted 24 hours a day. Lighting emissions have the potential to attract phototaxic plankton and foraging fish and may support foraging opportunities and increase predator-prey interactions (Keenan et al 2007; Cordes et al 2016). Offshore lighting may also attract seabirds to the area that may feed on fish aggregated near vessels (Weise et al 2001). Other potential environmental discharges from offshore vessels and equipment relate to the possible release of oily water and others substances through deck drainage, bilge / ballast water, open drains, sanitary waste/grey water, bunkering of fuel and drilling fluids from the vessels to the MODU, and other hazardous/non-hazardous wastes. Bilge and deck drainage water resulting from vessel operations or seawater interactions with ship equipment may contain hydrocarbons and other contaminants. Sewage discharge may lead to organic enrichment of areas that have either positive or negative effects on local fish and invertebrates (Peterson et al 1996).

As also discussed in Section 8.3.3 for the MODU, other potential issues include the possible introduction and spread of aquatic invasive species and resulting habitat degradation (Bax et al 2001; Morris et al 2010), although these effects are generally thought to be more of concern with respect to benthic coastal communities as compared to in the open ocean (Templeman 2010).

8.3.8.2 Residual Environmental Effects Assessment

With a single operating MODU there will be two to three return transits per week by the supply vessels during the course of the Project. In the case that two MODUs are operating at the same time, the number of transits could increase to between four to five trips (or more) per week. It is estimated that there would be one to three helicopter transits per day to the MODU, which would increase proportionally in

the event that two MODUs are being used simultaneously (i.e. two to six transits per day). Given the nature and frequency of any required aircraft support to the active MODUs (Section 2.5.2.6), and the planned avoidance of low level flights wherever possible (Section 8.3.2), no adverse environmental effects on fish and fish habitat are anticipated as a result of these activities.

As is the case for all marine traffic, the operation of these supply vessels will introduce a number of potential changes into the environment, including the noise, light and other possible emissions that are typically associated with such activities. All vessels that are used for this Project will meet the operational and environmental capabilities needed for the associated exploration activities, including for implementing relevant environmental mitigations and safety and emergency response procedures. All vessels will be in compliance with applicable legislation and regulations, and will be inspected by Transport Canada and approved for operation by the C-NLOPB before beginning any Project-related work. They will have appropriate oil spill / pollution prevention and emergency response plans in place, and each will be MARPOL compliant.

Atmospheric emissions during offshore activities would originate from vessel exhausts, although these would be negligible overall and will not have material, direct interactions with marine fish and fish habitat. Each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a Waste Management Plan in place that will be strictly adhered to throughout the life of the Project. Similar to the MODUs, all wastewaters will be treated to minimize contaminant or hydrocarbon levels prior to discharge in accordance with the OWTG and other regulatory requirements. The relatively low discharge volumes that are released high in the water column would likely become highly dispersed in the marine environment, and any discharges are unlikely to accumulate in any particular area due to the transitory nature of vessels.

Although the presence of these marine vessels may result in some degree of attraction, avoidance or other behavioural responses by individual fish (depending upon the species involved) (Røstad et al 2006; De Robertis and Handegard 2013), marine fish will likely not be disturbed by Project-related vessel activity, due to its transitory nature and thus its short-term presence at any one location, and because the Project's vessel movements will create noise types and levels that are similar to daily and frequent marine traffic in the area. Vessel noise will therefore not be a material or detectable contributor to any possible effects on marine biota.

Potential effects from supply and servicing are predicted to be adverse but low in magnitude, localized, of short term duration, occurring regularly and reversible, and are predicted with a high level of certainty.

8.4 Species at Risk: Overview of Potential Effects and Key Mitigation

A total of 16 fish species that are known or likely to occur within the LSA and/or RSA have been designated as species at risk and have associated protections under national or provincial legislation (SARA, NL ESA), or have otherwise been identified as being of special conservation concern by COSEWIC or under other processes. Several wolffish species, Atlantic cod, thorny skate and a number of species of grenadier and redfish are known or likely to occur within the area. Species including American eel, Atlantic salmon, shark species and Atlantic bluefin tuna may also seasonally migrate through the region.

As with secure fish species, species at risk may potentially interact with Project activities based on the occupation of various habitats at different life history stages (Table 8.5) and the same planned and proposed mitigation measures will be utilized to avoid or reduce any such adverse interactions. Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these Species at Risk is provided in Table 8.6.

Table 8.5 Marine Fish Species at Risk: Potential Interactions with Project Components by Life History Stage

Eggs	Larvae	Juveniles / Adults	Project Component / Potential Interaction
Freshwater			
• Atlantic salmon	• Atlantic salmon	• American eel	• No interaction
Marine - Demersal			
• Thorny Skate • Striped wolffish • Northern wolffish • Spotted wolffish	• Thorny Skate	• Atlantic cod • Roughhead grenadier • Roundnose grenadier • Thorny Skate • Acadian redfish • Deepwater redfish • Striped wolffish • Northern wolffish • Spotted wolffish	• Drilling and Associated Marine Discharges • Well Abandonment or Suspension • Vertical Seismic Profiling
Marine - Pelagic			
• Atlantic cod • Roughhead grenadier • Roundnose grenadier • American eel • Atlantic Bluefin tuna	• Atlantic cod • Roughhead grenadier • Roundnose grenadier • American eel • Atlantic Bluefin tuna • Acadian redfish • Deepwater redfish • Striped wolffish • Northern wolffish • Spotted wolffish	• Atlantic salmon • Acadian redfish • Deepwater redfish • Atlantic Bluefin tuna • Basking shark • Porbeagle • Shortfin mako • White shark	• Presence and Operation of MODU • Drilling and Associated Marine Discharges • Well Flow Testing/ Flaring • Supply and Servicing

Table 8.6 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	*SARA*	*NL ESA*	COSEWIC	Summary of Presence and Potential Interactions
Atlantic wolffish	Special Concern	-	Special Concern	• Spawns September and October • Pelagic larvae • Adults along slopes and rocky habitats • Abundant in Flemish Pass and continental slopes • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2), no critical habitat).
Northern wolffish	Threatened	-	Threatened	• Spawns September through November • Pelagic larvae and relatively pelagic adults

Species	*SARA*	*NL ESA*	COSEWIC	Summary of Presence and Potential Interactions
				• Aggregated in Flemish Pass and northeast slopes • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2) no critical habitat).
Spotted wolffish	Threatened	-	Threatened	• Spawn June, July and August • Pelagic larvae • Found on soft bottom habitats • Common on Flemish Cap, eastern Grand Banks and Newfoundland Shelf • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2), no critical habitat).
American eel	-	Vulnerable	Threatened	• Spawn in the Sargasso Sea • Pelagic larvae and adults • May pass through LSA or interact with vessels during migrations to or from spawning areas • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2), no critical habitat).
Atlantic cod (Newfoundland and Labrador population)	-	-	Endangered	• Eggs in the water column from April to October • Pelagic larvae • Distributed on the northeast and southeast tips of the Grand Banks and on the Flemish Cap • May pass through LSA during seasonal migrations • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2), no critical habitat).
Roughhead grenadier	-	-	Special Concern	• Spawning occurs in winter and early spring • Spawning grounds suggested to lie on the southern and southeastern slopes of the Grand Bank • Pelagic eggs • Common on the Flemish Cap Flemish Pass and nose of the Grand Banks • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)
Roundnose	-	-	Endangered	• Spawning occurs throughout the year • Mesopelagic eggs and juveniles

Species	*SARA*	*NL ESA*	COSEWIC	Summary of Presence and Potential Interactions
grenadier				• Common on the Flemish Cap and nose of the Grand Banks • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)
Thorny skate	-	-	Special Concern	• Widespread species on Grand Banks in shelf and slope areas • Undergo limited seasonal migrations • Limited potential for interaction (Project mitigations to minimize interactions (Section 8.3.2), no critical habitat)
Atlantic salmon (Multiple Populations)	-	-	Special Concern to Endangered	• Spawns in freshwater, growth phase in marine environments • May migrate through the LSA or interact with coastal and offshore service vessels. Mainly occupies upper 5-10 m of water column with some deeper feeding migrations. • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2), no critical habitat).
Acadian redfish (Atlantic population)	-	-	Threatened	• Common on the Northeast Newfoundland Shelf and Flemish Cap • Larval release between spring and summer • May migrate through LSA • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)
Deepwater redfish (Northern Population)	-	-	Threatened	• Common on the Northeast Newfoundland Shelf and Flemish Cap • Larval release between spring and summer • May migrate through LSA • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)
Atlantic bluefin tuna	-	-	Endangered	• May migrate through LSA • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2) • No known spawning or rearing habitats for early life stages in Canadian waters
Basking shark (Atlantic Population)	-	-	Special Concern	• Seasonal summer migrations into Canadian waters • May migrate through LSA

Species	*SARA*	*NL ESA*	COSEWIC	Summary of Presence and Potential Interactions
				• Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)
Shortfin mako (Atlantic Population)	-	-	Special Concern	• Seasonal summer migrations into Canadian waters • Associated with warm waters in and around the Gulf Stream • Not likely to migrate through LSA • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)
White shark (Atlantic Population)	Endangered	-	Endangered	• Seasonal, limited migrations into Canadian waters • Not likely to migrate through LSA • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)
Porbeagle	-	-	Endangered	• Abundant on the continental shelf of the Grand Bank • Mating grounds off Southern Newfoundland, the entrance to the Gulf of St. Lawrence and the Georges Bank • May migrate through LSA • Limited potential for interaction (mobile species, Project mitigations to minimize interactions (Section 8.3.2)

8.4.1 Wolffish

Wolffish eggs and adults are associated with bottom habitats and the larvae live pelagically (COSEWIC 2012 a,b,c). The general biology and distribution of wolffish species are discussed in Section 6.1.8. At this time, no critical habitat has been established for Northern or spotted wolffish as there is limited information on these species' life history, influences on population dynamics and information on acceptable targets for population abundance and range. No potential critical habitat has been established for striped wolffish as it is not a requirement of "special concern" *SARA* designation. While activities associated with this Project could potentially interact with areas of known wolffish occurrence, these are localized and short term activities and environmental disturbances. Furthermore, there are high aggregations of wolffish species outside the LSA, and use of planned and proposed mitigation measures will avoid or reduce any such adverse interactions with these species.

8.4.2 Grenadiers and Thorny Skate

Grenadier and skate species are typically associated with bottom habitats. The general biology and distribution of grenadier species and thorny skate are discussed in Section 6.1.8 Project activities interacting with the water column have potential to interact with the pelagic larvae of grenadier species and activities with demersal or benthic interactions may potentially interact with adult grenadier species and all life stages of thorny skate. Critical habitat has not been established for the roundnose grenadier

due to lack of information of habitat associations in relation to life history stages (DFO 2010). No critical habitat been established for roughhead grenadier, however spawning grounds for this species are suggested to lie on the southern and southeastern slopes of the Grand Banks (Scott and Scott 1988; COSEWIC 2007). No critical habitat for thorny skate has been established, but areas of high aggregation include the Newfoundland Shelf and Slopes (COSEWIC 2012d). As predicted Project-related disturbances are localized and short term, mitigations will be implemented to reduce potential effects, and there is no interaction with critical habitats, the potential for interaction with and adverse effects on these species is predicted to be limited.

8.4.3 Atlantic Cod

The general biology and distribution of Atlantic cod is discussed in Section 6.1.8 . Currently no critical habitat has been established for Atlantic cod. Project activities interacting with the water column and bottom habitats have the potential to interact with larval and adult cod. As predicted Project-related disturbances are localized and short term, mitigations will be implemented to avoid or reduce potential effects, and there are no interactions with critical habitat, there is limited potential for interaction with these species. Furthermore, adult Atlantic cod are highly mobile. The mobile adult stages would also be able to avoid affected areas and would likely be able to avoid any project related disturbances, minimizing any potential exposure to Project activities and thus, possible adverse effects.

8.4.4 Atlantic Salmon

Atlantic salmon interact with both freshwater and marine environments. Atlantic salmon migrate to freshwater to spawn and juveniles migrate to marine waters for their growth phase (COSEWIC 2010a). The general biology and distribution of this species is discussed in Section 6.1.8.

There are 16 Atlantic salmon populations across five regions delineated in terms of natal river destination and categorized as Designatable Units (DU) (Section 6.1.8.6). To date, there has not been any critical habitat established for this species, however freshwater habitat is considered a limitation to salmon production (COSEWIC 2010a). Each regional group assessed below has its own migration routes and overwintering patterns in marine waters.

8.4.4.1 Labrador and Nunavik Populations

There are 89 rivers in Labrador with known salmon populations; although it is noted that many of rivers with unknown status have never been surveyed (Reddin et al 2010). Marine survival of smolt to adult small salmon returning to Sand Hill River in 2013 has been estimated at two percent, which included both natural mortality as well as that from fisheries at sea (CSAS 2015). The degree of post-smolt migration to the Labrador Sea varies by population and geographic location of their home river; however, age analysis of salmon captured in the Labrador Sea, West Greenland, and off the east Grand Banks, indicate that post-smolt and adult salmon from Labrador generally feed and overwinter in the Labrador Sea and are not migrating or using habitat off the east Grand Banks. Multi-sea winter salmon also migrate to the north Labrador Sea and west Greenland during their second year to complete their growth prior to returning to home rivers to spawn. Genetic analysis of Atlantic salmon captured in coastal Labrador by fisheries indicated that the majority (85-98%) of individuals harvested over 2006-2011 were of Labrador origin and that those intercepted from more southern, non-local populations (e.g., Maritimes

and Gaspe Peninsula) were rare and occurred primarily in southern Labrador, consistent with discrete migrations pathways through the Strait of Belle Isle (CSAS 2015).

Given that the river ages of salmon located off the east Grand Banks are younger than those typical from Labrador rivers, the data suggests that most salmon from the Labrador region do not likely migrate to the more southern area of congregation and therefore interaction of these populations with the Project Area would be considered negligible.

8.4.4.2 Insular Newfoundland Populations

There are a total of 305 rivers with known salmon populations in Newfoundland (Reddin et al 2010). River age data suggests that salmon along the eastern edge of the Grand Banks would at least be partially of Newfoundland origin (particularly the southern portion of the Island). This would indicate that salmon of Newfoundland origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Banks in spring prior to completing their spawning migration back to their natal rivers. Catch data indicates that post-smolt do not overwinter in the Flemish Pass area (Reddin and Friedland 1993; Reddin 2006). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, prevailing currents along Eastern Newfoundland and the Grand Banks are generally a southern flow, therefore smolt energy expenditure would be higher particularly in the higher southerly flows of the Flemish Pass. It is likely that smolt would avoid these areas of increased southern flow while migrating north to the Labrador Sea and follow a generally more coastal route (CSAS 2013) before moving offshore. Acoustic tracking of smolt and kelt (CSAS 2013) from Conne River Newfoundland confirms this route. Based on tag recaptures, post-smolt from rivers in Newfoundland migrate near the coast of Eastern Newfoundland, arriving in the southern Labrador Sea in early August (Reddin and Friedland 1993). Tagging studies show that adult salmon migrating southward from feeding and overwintering areas to southern Newfoundland rivers in the spring first move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993).

In terms of habitat preferences, it has been shown that avoidance of lower water temperatures, particularly below 3ºC can play a predictive role in habitat use near the Grand Banks and Flemish Pass. Statistical summaries of sea temperature were derived from the Ocean Data Inventory (ODI) of the Bedford Institute of Oceanography (DFO 2016) for a rectangular area surrounding the Project Area, querying the period 1900 to 2016 for depths down to 3,000 m. For the area, mean Sea Surface Temperatures (SSTs) range from 1.6ºC in March to 5.3ºC in October. Minimum temperatures at the surface range from -1.8°C in January to 1.1°C in August and September. Maximum SSTs range from 4.0°C in March to 11.8°C in August. This seasonal temperature cycle is observed down to 250 m, where temperatures are higher in the summer than in winter. As shown, mean SST values greater than 3ºC occur between July and November and the preferred range (4-8ºC) can occur between July – October. Minimum SSTs for every month are below 3ºC.

The summary of available data regarding insular Newfoundland populations indicates that a portion of salmon spending one winter at sea (1SW) and multiple winters at sea adults, primarily from the southern Newfoundland population, congregate off the east Grand Banks prior to their spring spawning migration back to their natal river. Since the majority of known post-smolt overwintering occurs in the Labrador Sea, migration to the east Grand Banks area must occur; however, the exact migration route is not known and may be influenced by SST during the time of migration. For example, the monthly SST

values around the Project Area are a general indication that Atlantic salmon would not utilize the area outside the months July through to November and based on the SST temperatures recorded, if salmon utilize the area during the summer/autumn period (22 June – 22 December), it would likely be limited. As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were very low (0.0 – 1.0 fish per nautical mile of drift gillnet fished per hour) while efforts during winter had no catches near the Project Area. No life stage of Atlantic salmon is dependent upon the Project Area and any utilization is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3ºC. However, it should be noted that surveys of the area are limited and regional variations in abundance have been reported (DFO, pers comm).

Given the available data, there is likely low interaction with spring migration of adults within and near the Project Area. Potential interactions with the Project are also minimized by the localized and short term nature of activities, planned mitigations to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

8.4.4.3 Gulf of St. Lawrence Populations

As noted above, post-smolt are distributed according to prevailing surface currents and that strong currents act as transportation vectors that facilitate migration to marine feeding areas (Jonsson et al 1993) to reduce energy needs. This process appears to influence the migratory pathway for post-smolt within the Gulf of St. Lawrence region. For example, post-smolt from the north shore of the Gulf of St. Lawrence, as well as the Miramichi, Restigouche, and Cascapedia rivers, follow the coast eastward and use the Strait of Belle Isle as their major pathway during emigration to the North Atlantic (Lefevre et al 2012). Post-smolt from other rivers farther south on the Gaspe Peninsula have been recaptured near both the Strait of Belle Isle and Cabot Strait.

Caron (1983) and Dutil and Coutu (1988) concluded that some Gulf of St. Lawrence stocks delayed migration from the Gulf and that at least some post-smolt remained there until late autumn. Post-smolt have been captured as by-catch in herring gear in the northern Gulf of St. Lawrence in late summer (COSEWIC 2010a; CSAS 2012) and the winter destination of these late migrations remains unknown. Post-smolt within the Gulf of St. Lawrence were also recorded as spending more time in near-shore coastal habitat than smolt from other regions, which spend very little time in or near estuary habitat (COSEWIC 2010a). Once moving to open sea, post-smolt from the Gulf tend to head in a general northward direction (COSEWIC 2010a). This information suggests that post-smolt from the Gulf of St. Lawrence travel to the Labrador Sea primarily in a northerly route through the Strait of Belle Isle and eastward around the Island of Newfoundland. They may also delay migration away from estuary habitat and the Gulf in general until late fall and may overwinter in the Gulf area for their first winter.

CSAS (2012) indicates that the west Greenland fishery has captured salmon from Gulf of St. Lawrence rivers with an estimated harvest of 3-10 percent of total sea winter salmon being from the region (2006-2011). River age data suggests that salmon along the eastern edge of the Grand Banks would at least be partially of Gulf of St. Lawrence origin (particularly the southern portion of the Gulf of St. Lawrence). Similar to Atlantic salmon from the Southern Newfoundland population, salmon of Gulf of St. Lawrence origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Banks in spring prior to completing their spring spawning migration back to natal rivers. Post-smolt from this region would also be similar to those of insular Newfoundland in that they would not overwinter in the Flemish Pass area (Reddin and Friedland 1993). In terms of initial

post-smolt migration from their natal river to feeding areas in the Labrador Sea, it would also be likely that they follow a generally coastal route along Newfoundland before moving offshore (Reddin and Friedland 1993; CSAS 2013). Returning adults to the Gulf of St. Lawrence in the spring would also tend to move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993).

While spring migration through and near the Project Area is possible, salmon from the Gulf of St. Lawrence would be influenced by SST similar to other Atlantic salmon populations previously noted. Monthly SST values around the Project Area are a general indication that Atlantic salmon would not utilize the area outside the months July through to November and based on the SST temperatures recorded, if Gulf of St. Lawrence salmon utilize the area, it would likely be limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were very low (0.0 – 1.0 fish per nautical mile of drift gillnet fished per hour) while efforts near the Project Area during winter produced no catches. No life stage of Atlantic salmon is dependent upon the Project Area and any utilization is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3ºC. However, it should be noted that surveys of the area are limited and regional variations in abundance have been reported (DFO, pers comm).

Given the available data, there is a low potential for spring migration of adults to interact with the Project Area. Potential interactions with the Project are also minimized by the localized and short term nature of activities, planned mitigations to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

8.4.4.4 Eastern - Southern Nova Scotia and Outer Bay of Fundy Populations

In terms of marine use and distribution data, the Eastern – Southern Nova Scotia and Outer Bay of Fundy Atlantic salmon populations cannot be differentiated from that of Southern Newfoundland or the Gulf of St. Lawrence populations. Post-smolt migrating to the Labrador Sea and adults returning to natal streams in the spring would follow similar patterns of movement as described above; however, there is no evidence that post-smolt delay migration to the Labrador Sea.

Therefore, it can be assumed that salmon of this region feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Banks in spring prior to completing their spring spawning migration back to natal rivers. Post-smolt from this region would not overwinter in the Flemish Pass area (Reddin and Friedland 1993). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, it would also be likely that they follow a more general coastal route along the coast of Newfoundland (CSAS 2013; Reddin and Friedland 1993). Returning adults to the Gulf of St. Lawrence in the spring would also tend to move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993).

Although spring migration through and near the Project Area is possible, salmon from the Eastern – Southern Nova Scotia and Outer Bay of Fundy populations would be influenced by SST similar to other Atlantic salmon populations previously noted. Monthly SST values around the Project Area are a general indication that Atlantic salmon would not utilize the area outside the months July through to

November and based on the SST temperatures recorded, if Gulf of St. Lawrence salmon utilize the area, it would likely be limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were very low (0.0 – 1.0 fish per nautical mile of drift gillnet fished per hour) while efforts near the Project Area during winter produced no catches. No life stage of Atlantic salmon is dependent upon the LSA and any utilization is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3ºC. However, it should be noted that surveys of the area are limited and regional variations in abundance have been reported (DFO, pers comm).

Given the available data, there is a low potential for spring migration of adults to interact with the Project Area. Potential interactions with the Project are also minimized by the localized and short term nature of activities, planned mitigations to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

8.4.4.5 Inner Bay of Fundy Population

The Atlantic salmon population of the inner Bay of Fundy (iBoF) have been listed as endangered on Schedule 1 of SARA (CSAS 2016) and is the only population listed under the Act. Post-smolt from rivers in the iBoF have been observed to remain in the Bay of Fundy until late summer and while the exact overwintering location is unknown, lack of tag recoveries from distant intercept fisheries indicate the iBoF salmon do not go as far north as other salmon stocks and few are caught outside the Bay itself (COSEWIC 2010a). In 2013, DFO reviewed and evaluated the available iBoF salmon data to identify important marine and estuarine habitat needed to complete all life history stages (DFO 2013).

While the data available to determine habitat important for overwintering for all stages (November – April) is limited, overwintering is now suggested to be off the Scotian Shelf or the southern portion of the Gulf of Maine (CSAS 2016). As a result, interaction with the Project Area does not occur.

8.4.5 American Eel

American eels spawn in marine waters and larvae drift towards coastal environments where they enter freshwater systems to grow (COSEWIC 2012e). The general biology and distribution of this species is discussed in Section 6.1.8.

Adults migrate from rivers along the continental shelf to the Sargasso Sea where they spawn. As adult migrations follow the shallow shelf areas before moving directly to the Sargasso Sea in deeper waters, it is unlikely that the eels pass through the Project Area as it encompasses shelf areas that are distant from coastal regions (Béguer-Pon et al 2015). No critical habitat has been established for American eel (Wildlife Division 2010; COSEWIC 2012e), however it has been noted that freshwater riparian areas may be important habitat for developing eels (NL Wildlife Division 2010; COSEWIC 2012e).

As migration routes for American eel through the Project Area are possible but of low likelihood, any potential for Project interactions would be limited and overall risk is considered low to these species. Potential interactions with the Project are also minimized by the localized and short term nature of activities, planned mitigations to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

8.4.6 Redfish

Acadian and deepwater redfish are species with COSEWIC status designations that are well distributed in the Flemish Pass and Flemish Cap (Section 6.1.8). To date, no critical habitats have been established for these species, however it has been suggested that habitats made up of anemones and coral beds may be linked to redfish survival (COSEWIC 2010b). The general biology and distribution of these species are presented in Section 6.1.8. Previous studies indicate that adult redfish are able to avoid areas of disturbance (Popper and Hastings 2009). As predicted Project-related disturbances are localized and short term, mitigations will be implemented to reduce potential effects, and there is no critical habitat in the Project Area or RSA, there is limited potential for interaction with these species. Areas of relatively high aggregation on the slopes outside the LSA also limits regional population effects on these species.

8.4.7 Pelagic Species (Sharks and Tuna)

Shark species (basking, porbeagle, shortfin mako, and white sharks) and bluefin tuna that have COSEWIC status are highly mobile, pelagic seasonal species in Canadian waters. The general biology and distribution of these species in Canadian waters is described in Section 6.1.8. Atlantic bluefin tuna migrate to Canadian waters in summer in search of food and move southward in the fall. Critical habitat has not been established for Atlantic bluefin tuna and there are no known spawning or rearing habitats for early life stages of bluefin tuna in Canadian waters (COSEWIC 2011).

Basking, shortfin mako, and white sharks occur in Canadian waters in summer months, indicating they may be associated with the seasonal shift of warm Gulf Stream toward the coast. To date, no critical habitat has been established for these species (COSEWIC 2006a,b; 2009). For porbeagle sharks In Canadian waters, early, juvenile and adult life stages are abundant on or near the continental shelf (COSEWIC 2014). No critical habitat has been established for this species, however there are mating grounds that lie outside the LSA on the Grand Banks off southern Newfoundland, the entrance to the Gulf of St Lawrence, and the Georges Bank.

Tuna and shark species are highly mobile, pelagic species that may seasonally migrate though the LSA. With the implementation of Project mitigation measures any potential adverse effects would be unlikely.

8.5 Environmental Effects Evaluation

This section summarizes the residual effects of the Project on marine fish and fish habitat and presents a determination of significance for the environmental effects assessment for this VC.

8.5.1 Residual Environmental Effects Summary

As described throughout this chapter, the overall nature, localized extent and duration of the various components and activities associated with this Project, along with the offshore and dynamic marine environment involved and the planned implementation of standard and effective mitigations, will mean that any potential adverse effects on this VC will be of low magnitude, localized extent, temporary, and largely reversible in nature (Table 8.7). Moreover, the lack of interactions with critical habitat and areas

of known and high abundance outside the LSA also indicate that adverse effects to species at risk are considered unlikely.

The presence and operation of the MODU will result in the introduction of a number of disturbances into the marine environment, including underwater noise and vibrations, light emissions and other discharges, as well as resulting in direct interactions with the benthic environment, and possible issues related to aquatic invasive species. MODU presence, lighting and any organic waste emissions may result in some localized fish behavioural (attraction and aggregation) effects, whereas the noise associated with drilling or other activities such as the use of dynamic positioning may result in temporary avoidance by some individuals. Given their short-term and localized nature, however, these changes are not expected to have overall (population level) adverse effects on fish in the LSA or beyond. Drilling itself and any anchoring will result in direct interaction with the seabed, and could in turn adversely affect sensitive benthic biota or habitats in the immediate area (footprint). Potential effects on coral and sponge aggregations should be avoided through the completion of pre-spud surveys of the seabed using ROVs or other equipment, with appropriate mitigation (set-backs) applied as required and relevant. All associated discharges (wastewater, sewage, air emissions) from the MODU will be managed in accordance with applicable regulations and guidelines.

The primary environmental considerations associated with drilling activity itself are related to the discharge of WBMs and WBM-associated cuttings during the initial drilling phases, and the eventual discharge of SBM-associated cuttings from the MODU following their treatment and marine disposal in accordance with the OWTG. Drilling fluids themselves are essentially non-toxic, and these and all other chemicals used during the Project will be selected and used in accordance with applicable regulatory requirements and Nexen procedures. The marine disposal and deposition of drill cuttings (and any residual fluids) may cause a degree of accumulation on the seabed, but drill cuttings modelling carried out for the EIS indicates that the formed cuttings pile will be limited in size and distribution in this deep offshore environment. In only very limited areas will the cuttings pile thicknesses exceed the established thresholds for creation of anoxic areas and smothering of benthic species. Any cuttings accumulations on the seabed will eventually be recolonized following the completion of each of the up to 10 wells that may be drilled as part of this Project.

Underwater noise resulting from the use of seismic equipment during VSP activities may result in temporary displacement of some fish species, but is not anticipated to result in injury or mortality of fish and invertebrates. These seismic emissions are mainly directed downwards into the well, with limited horizontal range, and VSP surveys typically use sound levels that are lower than the larger seismic (geophysical) surveys that occur throughout the region. Mobile fish and invertebrate species are expected to temporarily avoid areas of VSP operations, minimizing the potential for adverse interactions. The application of standard mitigations such as an initial “ramp up” phase to increase initial fish and invertebrate avoidance will further limit any potential effects.

The environmental effects of well flow testing and associated flaring are related primarily to light and atmospheric emissions, and possible treated produced water discharges, as required. During well flow testing, oil and small quantities of produced water may be periodically flared, resulting in short term, localized and reversible air emissions, with little potential to interact with fish and their habitats. The amounts of produced water associated with exploration drilling are typically much lower than those from oil production, and any quantities that are in excess of the flare capacity will be treated in accordance with the OWTG and disposed of at the MODU site. The relatively low volumes of produced water

involved, coupled with its planned treatment prior to disposal and expected rapid dilution in this dynamic marine environment means that adverse effects on fish and fish habitat are unlikely to occur.

Eventual well abandonment or suspension and the associated removal of the wellhead using mechanical means (if required) will result in short term, low magnitude emissions of noise and light. Individual fish that are sensitive to lighting and noise emissions may temporarily avoid the area during these activities, with no anticipated population level effects or other adverse environmental implications occurring as a result of these activities.

Project-related supply and servicing vessels will make regular transits from an Eastern Newfoundland port to the Project Area during each exploration campaign, resulting in a degree of associated vessel noise, lighting and other environmental discharges such as wastewater emissions. These supply and service activities will comprise relatively routine and infrequent marine transits, similar to other types of marine traffic occurring offshore Eastern Newfoundland. All Project-related vessels (and aircraft) will follow applicable environmental and safety regulations and guidelines, and the transitory nature of these activities means that any environmental discharges are not likely to accumulate in any single area, and will not have detectable, adverse environmental effects upon marine fish and fish habitat.

Table 8.7 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *	
Summary of Existing Conditions and Environmental Context • The Project Area and LSA encompass areas of the Grand Banks including the Flemish Pass and the slopes of Newfoundland Shelf, and Flemish Cap. • Within this marine environment, habitats transition from relatively shallow shelf zones, through the continental slope to very deep abyssal regions; • These habitats are used by fish and invertebrate species of commercial, cultural, ecological and/or conservation importance, and support regionally important areas of biodiversity and marine productivity. • There are various species with COSEWIC or *SARA* status that have various life stages that reside in or migrate through the LSA.	**Key Mitigation Measures (See Section 8.3.2)** • Compliance with relevant regulations and guidelines; • Seabed investigations prior to drilling activities to assess benthic habitats, with associated ”set-backs” applied where relevant; • Where technically feasible, lower toxicity drilling fluids will preferentially be used; • Appropriate handling, storage, transportation and on-shore disposal of waste materials; • During any associated well testing, any produced hydrocarbons and small amounts of produced water will be flared using high-efficiency burners. If there is a significant amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge. • Reducing VSP source levels in the design and implementing a gradual ramp-up procedure to allow marine animals to move away from the area if they are disturbed by the underwater sound levels associated with a VSP; • Minimizing the amount of associated vessel and aircraft traffic, using existing and common travel routes where possible.

Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• Change in habitat availability and quality • Change in food availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance	A	L	L-LSA	S-M	R	R	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
	(behavioral effects)							
Drilling and Associated Marine Discharges (including fluids and cuttings)	• Change in habitat availability and quality • Change in food availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance (behavioral effects)	A	L	L-LSA	M-L	C	R	H
Vertical Seismic Profiling	• Change in fish mortality, injury, health • Change in fish presence and abundance (behavioral effects)	A	L	LSA	S	S	R	H
Well Testing	• Change in food availability and quality • Change in fish mortality, injury, health	A	L	L	S	S	R	H
Well Abandonment or Suspension	• Change in fish mortality, injury, health • Change in fish presence and abundance	A	N-L	L	S	S	R	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
	(behavioral effects)							
Supply and Servicing	• Change in fish mortality, injury, health • Change in fish presence and abundance (behavioral effects)	A	L	L	S	R	R	H

Evaluation of Significance

Not Significant

- The Project is not likely to result in significant effects on marine fish and fish habitat.
- Given the localized and short-term nature of Project-related activities, confidence is high that while the Project may adversely affect a small number of individuals in a localized area, these will be reversible. Effects are unlikely to alter the overall or long-term viability of local or regional populations
- The effects assessment for secure and at-risk species is the same and the Project is not likely to result in significant effects on species at risk.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

8.5.2 Determination of Significance

The Project is not predicted to result in significant adverse environmental effects on marine fish and fish habitat. This conclusion has been reached with an overall high level of certainty based on the nature and scope of the Project, knowledge about the existing environment within the LSA and RSA, and current understanding of the effects of similar projects on the VC and relevant, planned mitigation measures.

The primary mechanisms of interaction that may have negative effects on this VC include the noise, light, drill cuttings discharge, and other environmental emissions associated with the Project, including those that may result in direct interaction with and effects on the seabed and any sensitive benthic organisms or habitats. The overall nature and characteristics, localized extent and short-term duration of the various planned components and activities associated with this Project, along with the offshore and dynamic marine environment involved and the planned implementation of standard and effective mitigations, will mean that any adverse effects on this VC will be negligible to minor and spatially and temporally limited, and the number of individuals and habitat areas that may be affected by the Project is not anticipated to have any overall ecological or population-level effects. The Project will likewise not result in significant effects involving species at risk and their habitats.

8.6 Environmental Monitoring and Follow-up

Nexen will obtain the required authorizations for the Project, and comply with applicable regulations, guidelines, and mitigation measures as identified and committed to in the preceding sections, the implementation of which will be planned, managed, and monitored in accordance with existing operational procedures and policies. Based on the information presented in this EIS, and the conclusion of the effects assessment, a follow-up program will be undertaken in consideration of sensitive benthic habitat in the following circumstances:

1) When a planned well site is located within an identified FCA, or

2) In an area where the results of the pre-drill seabed investigation and subsequent review by DFO and C-NLOPB indicate that monitoring is required.

The purpose of the program would be to determine the effectiveness of mitigation measures in protecting the sensitive benthic habitat. It may include parameters such as:

- Post-drilling seabed core samples to measure drill cuttings deposition; and/or

- Post-drilling visual assessment using high-definition images / video

If exploration wells are planned to be drilled under the circumstances identified above, a follow-up monitoring plan will be developed and submitted for DFO and C-NLOPB for review prior to commencement of drilling.

8.7 References

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9 MARINE AND MIGRATORY BIRDS: ENVIRONMENTAL EFFECTS ASSESSMENT

The waters off Eastern Newfoundland support a diversity of avifauna species throughout the year, including seabirds that inhabit the region at particular or extended periods, as well as coastal species and landbirds that are found in nearshore and offshore areas for feeding, migration and other activities. Eastern Newfoundland also contains a number of identified important habitats for birds along its coastline, well outside of the Project Area, although Project-related vessel and aircraft traffic will originate from shore.

Most migratory birds found in Canada are protected under the federal *Migratory Birds Convention Act* (MBCA) and its regulations. Further, wildlife in Newfoundland and Labrador (including certain species not protected under the MBCA) are managed under the provincial *Wildlife Act* and regulations. Avian species at risk and their habitats, including some species that are known or have potential to occur in the Project Area and surrounding environments, are protected by both the federal *Species at Risk Act* (SARA) and the Newfoundland and Labrador *Endangered Species Act* (NL ESA) legislation. In addition to these legal protections, birds have intrinsic ecological and socioeconomic value. They often function near the top of the food chain and may be relatively vulnerable to certain types of environmental disturbance. Some species are also an important resource for recreational and tourism-related pursuits. The assessment of this VC considers all avian species at risk in a fully integrated manner including species that are listed under SARA and NL ESA and other species that are considered to be of special conservation concern.

9.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

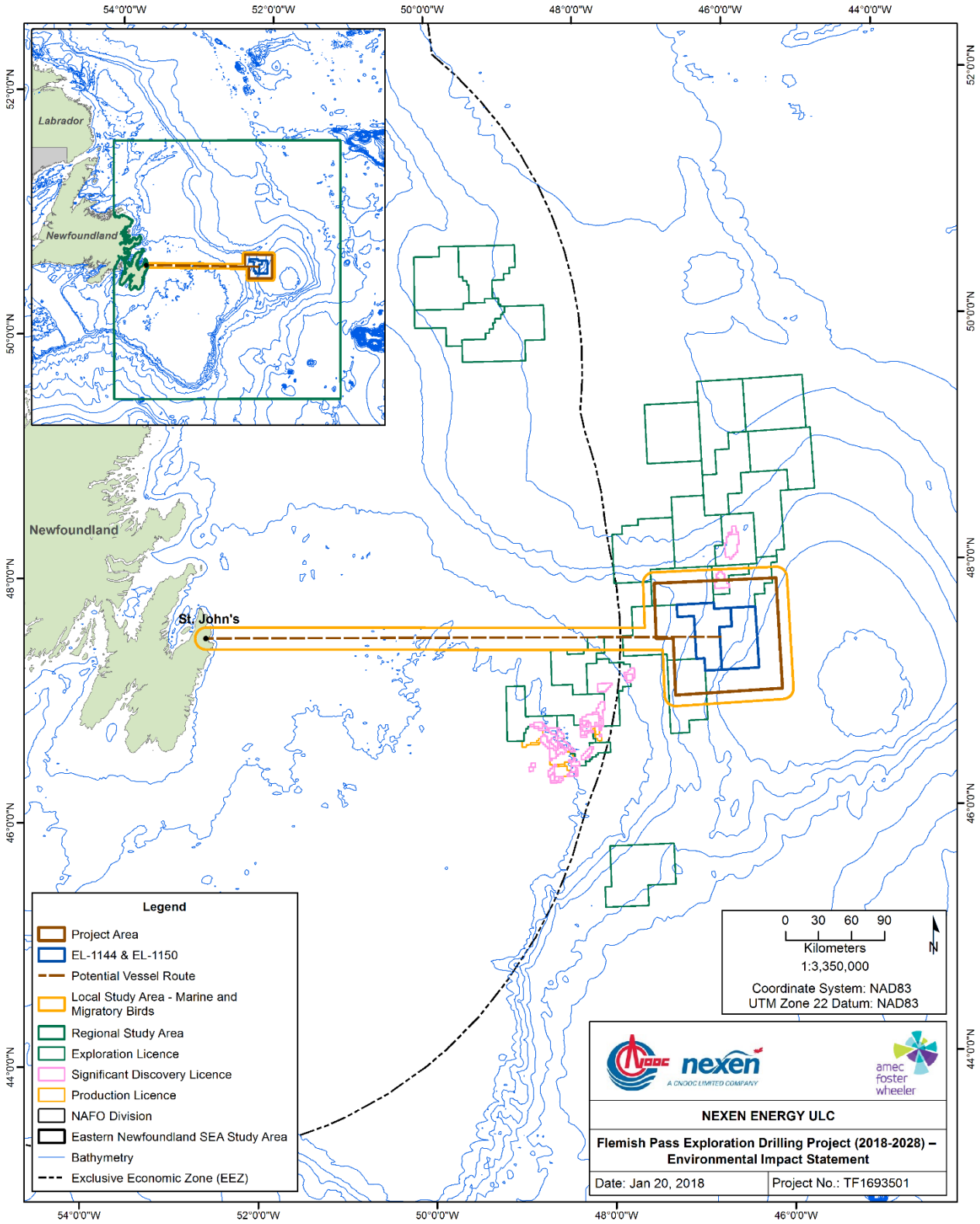
This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for marine and migratory birds.

9.1.1 Spatial Boundaries

A number of spatial assessment boundaries have been defined for the environmental effects assessment of this VC, which reflect the varying ways and scales in which the Project may influence birds and their habitats. These Study Areas are defined as follows (Figure 9.1):

Project Area: This area encompasses the overall geographic area offshore Eastern Newfoundland within which all planned Project-related exploration activities will take place. This includes ELs 1144 and 1150, within which drilling will occur, as well as a surrounding 20 km buffer area to account for any ancillary activities (such as walk away VSP surveys) that may extend outside the boundaries of the ELs themselves. While the Project Area is defined as an overall polygon that encompasses all such activities over the course of the Project, the various activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply vessel and aircraft traffic to and from this offshore Project Area. Section 6.2.7 shows the Project Area and transit route in relation to known seabird colonies and other important habitats.

Figure 9.1 Marine and Migratory Birds: Environmental Assessment Study Areas



Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's components and activities, and therefore, encompasses the overall geographic area over which all planned Project-related environmental interactions (including any emissions and other disturbances) are predicted to occur. As described in this chapter, the main Project-related environmental emissions and interactions that have the potential to affect birds include air and light emissions and waste materials that may be generated by the active MODU(s) and support vessels, which are anticipated to be confined to within several kilometers of the source and the immediate vicinity of the associated support vessel and aircraft traffic routes to the ELs. For this VC, the LSA is therefore (conservatively) defined as the Project Area and the associated vessel and aircraft traffic route, and an approximately 10 km area around these.

Regional Study Area (RSA): Ecological boundaries for marine and migratory birds vary between species, due to difference in their ranges, habitat preferences, movement patterns and key activities. The EA assesses potential effects to birds (individuals and populations) which are known or likely to use the LSA, and considers the overall extent of any affected individuals and populations during the time period at which they may be affected by planned Project components and activities. Key aspects of marine biota movements and distributions as they relate to the Project Area / LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this Chapter) and cumulative (Chapter 15) effects upon this VC. The overall RSA for the environmental effects assessment is as defined and illustrated earlier in Section 4.3.1

9.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the potential duration of Project-related activities in the Project Area (2018-2028, see Section 2.7), as well as the likely timing of any resulting environmental effects. In conducting the assessment, special consideration is also given to timing of VC presence within the Project and Assessment Areas, including any particularly important or sensitive periods. Section 6.2 provides details of marine and migratory bird species known to occur, and their timing of presence, within these areas.

9.1.3 Environmental Effect Significance Definitions

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects on this VC and their significance are assessed and evaluated.

Significant environmental effects on marine and migratory birds are defined as those that would cause one or more of the following:

- *A detectable decline in overall bird abundance or change in the spatial and temporal distributions of bird populations within the overall RSA over multiple generations*

- *Effects to a designated (protected) species at risk such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected.*

9.2 Potential Environmental Changes, Effects and Associated Parameters

The key potential environmental interactions between project activities and marine and migratory birds – including the associated environmental changes and possible resulting environmental effects on this VC – include the following, as summarized and adapted from the Eastern Newfoundland SEA (Amec 2014):

- Attraction of night-flying birds to MODUs and support vessels, including their lights, flares or other emissions, resulting in possible injury or mortality (strikes, strandings, disorientation, increased energy expenditure, increased predation);

- Disturbance to birds and their activities as a result of activities and equipment associated with oil and gas activities (lights, noise), resulting in possible injury or mortality;

- Potential injury or other associated disruptions to and changes in feeding and other behaviours (particularly for diving birds), as a result of exposure to seismic noise within the water column during VSP;

- Changes in the availability, distribution and/or quality of food sources or habitats for marine and migratory birds due to disturbances (noise, light) and/or project-related environmental emissions (such as drilling fluids, other liquid and solid waste materials); and

- Changes in the presence, abundance, distribution or health of birds as a result of direct exposure (e.g. physical exposure or ingestion) to environmental emissions from installations or vessels, which may affect individuals, populations and important habitats.

The EIS Guidelines also identify and specify a number of issues and potential effects on this VC which require consideration in the EIS (Part 2, Section 6.3.5). These are listed in detail in the Table of Concordance included at the beginning of the EIS.

A number of questions and comments related to this VC were also noted during Nexen's Project-related consultations with government departments and agencies, stakeholder organizations and Indigenous groups (see Chapter 3 for further details). These include concerns regarding the potential effects of the Project on migratory bird species that are harvested for traditional purposes by Indigenous groups (Section 7.4), particularly in the unlikely event of a large oil spill (see Chapter 16).

The environmental effects assessment for this VC considers and focuses upon the various issues and questions identified through these various issue scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects. These are summarized in Table 9.1, along with the identification of key parameters through which these Project-related changes and effects may be reflected.

Table 9.1 Potential Project-Related VC Environmental Changes and Resulting Effects: Marine and Migratory Birds

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• Offshore oil and gas related activities have the potential to result in mortality, injury or sub-lethal health effects on avifauna at the individual or even population level. • These effects can result from environmental changes such as the presence of offshore platforms and increased light levels or flaring, leading to bird strandings or incineration. • Releases of project-related wastes (e.g.,drilling fluids) during planned and routine activities may cause contamination leading to resulting health effects. • Artificial lighting and other environmental emissions and disturbances can also lead to increased rates of predation.	*Change in Mortality / Injury Levels and Bird Health*	• Levels of avian injury or mortality. • Numbers of individuals and species present in the Project Area or LSA. • Predator numbers and levels of predation. • Occurrence and success of key life history stages (e.g., reproduction)
• Increased mortality and sub-lethal health effects can have resulting effects on the presence, density and diversity of marine-associated avifauna and their populations. • Birds may be attracted to offshore facilities by associated environmental changes (such as food availability) or by disorientation due to anthropogenic lights or flares. • Some species may avoid the area because of sensory disturbances or other changes in the marine environment associated with the Project (e.g. disturbance due to vessel traffic; increased presence of predatory species attracted to the Project Area). • Avoidance or attraction of individuals (behavioral effects) can influence the overall presence (both spatial and temporal) and the abundance or birds in the area. • Behavioural changes can have population level effects if access to key habitats is lost for extended periods of time, or if key and sensitive life history stages are disrupted.	*Change in Avifauna Presence and Abundance (Behavioural Effects)*	• Avian abundance and diversity (number of species) present in the Project Area / LSA. • Overall patterns of spatial and temporal distribution patterns in the LSA and beyond. • Occurrence and success of key life history stages (e.g., reproduction)

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• Displacement of birds due to changes in their habitats associated with Project-related components, activities and associated emissions or disturbances. • Changes in the availability, extent and quality of habitats for birds have the potential to affect the health of birds in the affected areas, as displacement from or loss of important habitats can result in increased energy expenditure.	*Change in Habitat Availability and Quality*	• Location, extent and relative abundance of key habitat types in the Project Area / LSA. • Avifauna distribution and use of key habitats.
• Changes to the availability, quantity and quality of food sources, such as marine fish, invertebrates, other birds, and organic waste generated from Project, can potentially affect the presence, abundance and health of birds.	*Change in Food Availability or Quality*	• Prey quantity, quality and availability Project Area / LSA. • Volume of organic waste released and consumed.

An overview of the potential for each of the Project's planned components and activities to result in one or more of the above noted potential environmental effects on this VC is presented in Table 9.2.

Table 9.2 Potential Project-VC Interactions and Associated Effects: Marine and Migratory Birds

Planned Project Component / Activity	Potential Environmental Effects			
	Change in Mortality / Injury Levels and Bird Health	**Change in Avifauna Presence and Abundance (Behavioral Effects)**	**Change in Habitat Availability and Quality**	**Change in Food Availability or Quality**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●	●	●
Drilling and Associated Marine Discharges (including fluids and cuttings)	●			●
Vertical Seismic Profiling	●	●		●
Well Testing	●	●		
Well Abandonment or Suspension				
Supply and Servicing	●	●		

9.3 Environmental Effects Assessment and Mitigation

The potential effects of the Project's planned components and activities on marine and migratory birds are assessed and evaluated in the following subsections. Mitigation measures to prevent or reduce potential adverse effects upon this VC are identified in Section 9.3.2 and considered throughout the environmental effects analysis that follows. The environmental effects assessment for unplanned (accidental) events for all VCs, including this one, is presented separately in Chapter 16.

9.3.1 Approach and Methods

The environmental effects assessment for marine and migratory birds entails an analysis of the potential interactions between the Project and the VC. A review of available literature was conducted, and pertinent knowledge of the potential interactions (summarized in the following sections) has been used to inform the effects analysis and identification of applicable mitigation measures. Known and likely environmental issues and interactions with the VC are detailed in other sources such as the Eastern Newfoundland SEA (Amec 2014) and primary literature (e.g. Ellis et al 2013; Ronconi et al 2015). In the assessment, each planned component of the Project is considered in terms of its potential for interactions with the VC, with a focus on the potential environmental changes and resulting effects that were identified in the previous section.

9.3.2 Summary of Key Mitigation

Key mitigation measures that will be implemented in relation to the Project to help avoid or reduce potential environmental effects on marine and migratory birds include (see also Section 8.3.2)::

a) Nexen will operate in accordance with the *Measures to Protect and Monitor Seabirds in Petroleum-Related Activity in the Canada-Newfoundland and Labrador Offshore Area*.

b) Where possible, known and observed bird colonies, other significant aggregations of avifauna, and other identified sensitive areas will be avoided in the planning and conduct of Project-related exploration activities as per requirements of the *Seabird Ecological Reserve Regulations*, 2015, which prohibit aircraft flying at an altitude of less than 300 m over ecological reserves over specified time periods.

c) The frequency of vessel and aircraft traffic transits associated with the Project will be minimized to the extent possible. Low-level aircraft operations will also be avoided, wherever possible and feasible.

d) Environmental discharges and emissions from planned operations and activities will be minimized, and will comply with relevant regulations and standards.

e) Operational liquid discharges will be treated prior to release in compliance with the OWTG and other applicable regulations and standards, and oil-water separators will be used to treat contained oil-contaminated fluids, with collected oil properly stored and disposed of.

f) During any associated well testing, any produced hydrocarbons and small amounts of produced water will be flared using high-efficiency burners. If there is a significant amount of produced

water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge.

g) Appropriate measures will be implemented for the handling, storage, transportation and on-shore disposal of solid and hazardous wastes throughout the Project.

h) Maceration of sewage and kitchen waste will be conducted in accordance with MARPOL and the OWTG.

i) Project-related artificial lighting will be minimized to the greatest extent possible without compromising safety.

j) Flaring will be kept to the minimum amount necessary to characterize the hydrocarbon accumulation and as necessary for the safety of the operation. High efficiency burners will be used when flaring is required, and the Project will consider flare shields if technically and safely feasible. In accordance with C-NLOPB's *Measures to Protect and Monitor Seabirds in Petroleum-Related Activity in the Canada-Newfoundland and Labrador Offshore Area*, Nexen will notify the C-NLOPB of plans to flare so that the Board may consult with ECCC-CWS to determine a safe timeline to proceed to minimize effects on migratory birds.

k) Selection and screening of chemicals will be undertaken pursuant to the OCSG. Where technically feasible, lower toxicity drilling fluids will preferentially be used.

l) Seismic sound levels will be kept at the minimum level possible required during VSP in compliance with the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*. At the commencement of the survey activity, a gradual "ramp-up" procedure of the seismic source array will be implemented in order to allow any mobile marine animals to move away from the area if they are disturbed by it. There will also be a planned shut-down of the seismic sound sources or reduction to the smallest, single source element during maintenance activities.

m) Routine searches for stranded birds will be conducted on the MODUs and supply vessels, and appropriate programs and protocols for the collection and release of marine and migratory birds will be implemented for any birds that become stranded, including ECCC-CWS's *Oiled Birds Protocol and Protocol for Collecting Dead Birds From Platforms*, *Best Practices for Stranded Birds Encountered Offshore Atlantic Canada* (Draft 2), and Williams and Chardine (n.d): *The Leach's Storm Petrel: General Information and Handling Instructions*. Nexen will obtain the necessary Seabird Handling Permit from ECCC-CWS.

9.3.3 Presence and Operation of MODUs

Potential interactions between the VC and the presence and operation of the MODU and its associated standby vessel(s) include: possible attraction of birds due to lighting, avoidance of the MODU due to sensory disturbance, and the creation of new foraging opportunities for predator species through mechanisms such as prey attraction due to organic waste disposal and presence of incapacitated or dead prey.

9.3.3.1 Overview of Potential Effects and Existing Knowledge

Offshore platforms have been found to attract marine birds, primarily due to artificial lighting (Ronconi et al 2015), and this phenomenon has been noted in several studies. Tasker et al (1986), for example, noted higher densities of birds within 500 m of a platform when compared to the surrounding waters, Baird (1990) found that bird densities were six to seven times higher than previously observed following construction of a new platform in the Bering Sea, and Wiese and Montevecchi (2000) found that seabird concentrations around offshore oil platforms and vessels on the Grand Banks were 19 to 38 times higher than areas away from such structures.

This attraction can result in direct mortality or injury through collisions with facility infrastructure, or through disorientation (e.g., birds flying around artificial lights) resulting in costly increases in energy expenditure (Baird 1990; Montevecchi et al 1999; Wiese and Montevecchi 2000). Bruinzeel and van Belle (2010) reported that most bird mortality on offshore platforms was due to collision. However, disoriented birds may also deplete energy resources, delay foraging or migration behaviours, or even increase susceptibility to predation (Bourne 1979; Sage 1979; Wiese and Montevecchi 2000; Wiese et al 2001; Jones and Francis 2003; Schummer and Eddleman 2003; Bruinzeel and van Belle 2010). Night-feeding seabirds such as shearwaters and storm-petrels may mistake the lighting for bioluminescent prey (Imber 1975; Wiese et al 2001; Gauthreaux and Belser 2006; Poot et al 2008). In addition to marine bird species, landbirds may also be affected by presence and operation of MODUs, as many landbirds navigate nocturnally using visual cues, and artificial lights may be mistakenly used as navigational cues (Wiese et al 2001; Gauthreaux and Belser 2006; Poot et al 2008). However, studies have found that coastal lighting may be more of an influence than offshore light sources, as most migrating landbirds tend to fly closer to land (Weir 1976; Blomqvist and Peterz 1984), and typically avoid geographical barriers such as large stretches of open water (Marquenie et al 2008).

Meteorological factors can influence the attraction of birds to offshore oil and gas installations, as studies have shown that drizzle, fog, or otherwise reduced visibility appears to result in increased attraction to light (Gauthreaux and Belser 2006; Montevecchi 2006). In fog or drizzle, the moisture droplets in the air refract the light and greatly increase the illuminated area, thus enhancing attraction (Wiese et al 2001), and these conditions are not uncommon offshore Eastern Newfoundland. Bruinzeel and van Belle (2010) found that the distance at which birds become disoriented ranges from 200 m in dense fog to 1000 - 1400 m in lighter fog and light rain, to up to 4.5 km in overcast skies with no celestial cues and otherwise good visibility.

Lighting is required for worker safety on all offshore installations and vessels, and must be designed first and foremost for safe operation. Alterations or adjustments to facility lighting may be considered only if safety is not compromised. Poot et al (2008) found that birds could be attracted to fully lit (30 kW) oil platforms from a distance of up to five kilometers. Bird attraction has been found to be highly correlated with lighting intensity (Marquenie and van der Laar 2004; Marquenie et al 2013), and when platform lighting was reduced from full illumination to only beacon and obstruction lights the number of birds observed circling the platform was greatly reduced. Shielding lights downward has also been shown to reduce attraction (Reed et al 1985). Additionally, the wavelength and intensity of lighting have been shown to influence the degree of attraction; white and red-coloured lights are associated with the highest levels of mortality, while blue and green lights appear to result in considerably less attraction (Gautreaux and Belser 2006; Poot et al 2008; Marquenie et al 2013).

In addition to attraction of birds to artificial lights, the presence of offshore platforms can also be used as “artificial archipelagos” by marine-associated birds (Russell 2005) Structures may be used as roosting and resting sites by gulls (Burke et al 2012), as stopover locations for migrating landbirds who may forage around the platforms (Russell 2005; Bruinzeel and van Belle 2010), or even potentially as hunting grounds for predatory species which take advantage of concentrations of birds around the structures (Russell 2005). As well, foraging opportunities may be enhanced around platforms because they themselves may become artificial reefs around which new invertebrate and fish assemblages are established (Fabi et al 2002, 2004).

The displacement of birds due to offshore installations has also been documented (Bramford et al 1990). Alcid distributions along survey transects to platforms on the Grand Banks were more strongly related to ocean temperature than proximity to platforms (Burke et al 2005), although these attraction effects differed among species and seasons (Burke et al 2012). Baird (1990) found that puffins, unlike most seabird species, occurred at lower densities within 10 km from the platform than further away. Alcids are prone to disturbance from vessel traffic, which is thought to at least partially explain this avoidance behaviour around platforms (Ronconi and St Clair 2002; Bellefleur et al 2009). Observed densities of Dovekie, Northern Fulmar, shearwaters, and storm-petrels on the Scotian Shelf were lower within 10 km of oil production platforms (relative to areas more than 10 km from platforms) suggesting some avoidance of platforms by certain species, although the effects of habitat preferences were not assessed (Amec 2011).

It is somewhat difficult to quantify the numbers of birds potentially killed by collisions or disorientation associated with offshore installations and vessels because the available estimates rely on recovery of birds on platforms and vessels, and it is not known how many birds are killed but not recovered (i.e. due to scavenging or landing in the ocean; see Montevecchi et al 1999; Bruinzeel et al 2009; Ellis et al 2013). Carcass recoveries are often conducted on an incidental basis, and this provides limited spatial and temporal coverage compared to a more systematic observer-based monitoring system (Ronconi et al 2015). Nonetheless, even incidental information from industry-based monitoring is helpful to determine seasonal and weather-related patterns in strandings, and to determine which species are likely more susceptible to this phenomenon. Environment Canada (2015) notes that Leach’s Storm-petrels are the most commonly found species stranded on vessels in Atlantic Canada. Previous observations reported in the region can be used to provide an estimate of the species composition and relative rates of strandings and mortalities. For example, in their comprehensive study for the White Rose Project, Husky Energy (2000) stated that 52 Leach’s Storm-petrels were recovered and released from aboard a Terra Nova vessel over a three week period during the summer of 1998 with no mortality observed. Baillie et al (2005) reported 469 stranded birds (mostly Leach’s Storm-petrels) at offshore installations and vessels off Newfoundland between 1998 and 2002, of which nine were reported to have died and 213 were released (the fate of the rest of the birds was not reported), and Ellis et al (2013) reported similar results between 2003 and 2006 on the Grand Banks.

9.3.3.2 Residual Environmental Effects Assessment

On-board lighting will be required for all Project activities that occur at night and during periods of low visibility, and this must be in place and activated for worker safety and regulatory compliance reasons. The MODU will be situated over 400 kilometers offshore, which is far from coastal breeding sites and IBAs, and well beyond the foraging range of almost all species that nest in Newfoundland and Labrador. Overall, the presence and operation of the MODU(s) in the Project Area is anticipated to be a negligible

addition to the total amount of lighting in this offshore area, especially as compared to the fishing boats, existing offshore installations (production and exploration), commercial traffic and other vessel movements that regularly move to and through the Project Area throughout the year. The distance at which Project-related lighting in the offshore environment will be visible (and thus, its likely zone of influence) may be up to five kilometers (Poot et all 2008), although this will be influenced by site and time specific factors including weather. Periods of drizzle and fog and overcast conditions may increase potential for attraction of birds (Wiese et al 2001; Bruinzeel and van Belle 2010). Although the MODU will be situated outside the foraging range of most species, the Leach's Storm-petrel is known to make foraging trips of thousands of kilometres during the breeding season (Pollet et al 2014). The MODU will take up to 160 days to drill and evaluate any particular well at a specific location, and so any disturbance will be short- to medium-term and transient in nature. Therefore, predicted effects on most breeding birds will be minimal.

While there is some potential for the attraction of migratory landbirds, particularly during the fall period, most migrating landbirds tend to fly closer to land (Weir 1976; Blomqvist and Peterz 1984), and so it is unlikely that large numbers of birds will be affected due to the distance of the MODU from shore. Mitigation measures outlined in Section 9.3.2 will be in place during Project operations to further reduce the potential effects of attraction due to offshore lighting. Use of lighting will be minimized only as long as worker safety is not adversely affected, for example by minimizing unnecessary lights, shading (if possible), and directing light into the work area (also known as task lighting). There are safety concerns with some types of spectral lighting, particularly blue light (Poot et al 2008). Shorter-wavelength (low-red) lighting has been implemented in certain situations with no implications on worker safety (Marquenie et al 2013); however, its use in offshore Newfoundland and Labrador is restricted by its limited capability in extreme weather and safety concerns related to helicopter approach / landing when helicopter windows are glazed with a UV-blue filter, as well as limited commercial availability and lower energy efficiency (Marquenie et al 2013).

Some species such as alcids may avoid the area around the MODU, resulting in some habitat displacement during drilling operations. The effect of habitat displacement on marine-associated birds is considered to be minor, except potentially in areas such as the North Sea where platforms occur in high concentrations, or when they are situated on or near productive sites associated with discrete physiographic features such as continental shelf edges and slopes (Hedd et al 2011; Ronconi et al 2015). However, any such displacement effects, if they do occur, will be temporary and transient in nature, as stated above, because the MODU will not be situated in any one location for extended periods of time. As well, because the area of displacement is small relative to the total areas of highly productive feeding grounds within the LSA (and relative to the overall ranges of these species), foraging activities will not be materially disrupted. The MODU will be far from coastal breeding sites and IBAs at all times, so potential effects on nesting birds and key habitats are not anticipated. Implementation of mitigation measures to minimize levels of light, sound, atmospheric emissions and wastes and adherence to appropriate performance targets described in Section 9.3.2 will further reduce the degree to which any marine and migratory birds are displaced from key habitats.

The possible creation of new habitats and increased food availability associated with presence and operation of the MODU will likewise be short term at any particular location, and this may result in both positive and negative effects on marine and migratory birds. Enhancement of the local food supply and provision of roosting sites may attract birds to platforms, but the benefits in terms of energy gains may be offset by increased exposure to risk of collision with the MODU or predation as well as energetic

costs due to deviation from normal movement/migration patterns. Proper waste management, particularly with regards to disposal of organic wastes, will reduce the degree to which foraging opportunities are enhanced by the presence and operation of the MODU.

Based on the information and analysis summarised here, and with the implementation of appropriate mitigation measures as summarized in Section 9.3.2, the overall magnitude of the potential effect of the presence and operation of the MODU on marine and migratory birds is anticipated to be low. There may be a slight increase in mortality / injury levels due to collisions, disorientation and potential predation, although the mortality rate is anticipated to be low as many stranded birds encountered on offshore installations and vessels are released successfully. Some localized and short-term behavioral effects (change in presence and abundance) are also likely to occur, with some species displaced from the LSA and others attracted by lighting and created foraging opportunities. The localized, transient and short-term nature of these disturbances at any one location and time during the Project considerably reduces the potential for adverse effects upon marine and migratory birds (individuals or populations) to occur. It is therefore very unlikely that any individuals will be attracted or displaced over extended areas or timeframes. Given that the likely zone of influence of the Project at any one time or location will represent a very small proportion of the available feeding, breeding or migration area of any species, birds will not be displaced from any key habitats or during important activities, or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region. Any changes in habitat and food availability will also be on a very localized scale and temporary in nature.

In summary, the predicted environmental effects of presence and operation of the MODU are primarily related to lighting and other emissions. These effects are predicted to be adverse, low in magnitude, localized to within the LSA, short- to medium-term in duration, regular in frequency, and reversible, with a high level of certainty.

9.3.4 Drilling and Associated Marine Discharges

Expected and potential environmental emissions and discharges associated with the Project will include drilling wastes (fluids, cement and cuttings), other liquid wastes (bilge and deck drainage, ballast water, grey and black water, cooling water and fire control water), atmospheric emissions (exhausts from equipment, as well as emissions from hydrocarbon storage and flaring), and solid wastes including food and other non-hazardous waste. These emissions are described in Chapter 2 (Project Description).

9.3.4.1 Overview of Potential Effects and Existing Knowledge

Wastes generated from drilling include drilling fluids and cuttings. Chemical composition of fluids and allowable discharge volumes associated with drilling fluids and cuttings are regulated in compliance with the OWTG (Morandin and O'Hara 2016). Produced water typically accounts for the largest volume of waste from offshore oil and gas production operations (Neff 2002), and in calm conditions, discharges within allowable levels can result in formation of hydrocarbon sheens of up to 3 µm thickness (ERIN Consulting Ltd and OCL Services Ltd 2003; Morandin and O'Hara 2016). This issue is, however, far less of a concern for exploration drilling, where produced water volumes (if they do occur) are very small (Morandin and O'Hara 2016). If commercial hydrocarbons are found during an exploration drilling program, formation fluids, which may contain hydrocarbons and/or water, flow to the MODU where they are often tested. During such testing, produced hydrocarbons are separated from any produced water on the MODU and analysed. Small amounts of produced water will be flared along with the produced

hydrocarbons; if there is a significant amount of produced water, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge.

Deck drainage and bilge waters, if not properly treated, have the potential to negatively affect marine bird health because of the presence of residual hydrocarbons. Routine operational discharges from vessels and offshore installations may lead to hydrocarbon sheens from SBM cuttings, treated bilge or cooling water, and other substances on the water's surface to which marine and migratory birds, especially pelagic seabirds, may be exposed and affected; this is referred to as chronic oil pollution (Wiese and Robertson 2004; O'Hara and Morandin 2010; Morandin and O'Hara 2016). Small amounts of oil from sheens has been shown to affect the structure and function of seabird feathers, which has the potential to result in water penetrating plumage and displacing the layer of insulating air, resulting in loss of buoyancy and hypothermia (O'Hara and Morandin 2010). This can in turn cause a heightened metabolic rate, and can lead to behavioural changes at the expense of foraging and breeding (e.g. increased time spent preening); this can be fatal to seabirds, especially in the winter months when conditions are colder and thermoregulation is most difficult (Morandin and O'Hara 2016).

Butler et al (1986, 1988) and Trivelpiece et al (1984) have found effects from relatively low levels of oil on Leach's Storm-petrel metabolic rate, and so this species may be particularly vulnerable to potential effects of hydrocarbon exposure. In very calm sea conditions, the treated discharge of some operational wastes may cause surface sheening; however, the potential for sheen formation is reduced with adherence to the OWTG (i.e., proper treatment and management of operational discharges). Observations of sheens in the Canada-NL Offshore Area are reported to C-NLOPB. On average, the number of reported sheens off production platforms in the Grand Banks between 2003 and 2014 was 24 per year (Morandin and O'Hara 2016). Data from ERIN Consulting Ltd and OCL Services Ltd (2003) showed that sheens of 1 µm persist for up to 24 h, while thinner (0.1 µm) sheens tended to disperse in less than an hour. Based on the perceived colour of sheens observed in the Grand Banks, the thickness was estimated to be in the range of 0.07 - 1 µm for any sheens where descriptions were provided. It is thought that thicker sheens, which are more persistent and therefore pose greater potential for interactions with seabirds, are rare in routine offshore operations (Morandin and O'Hara 2016), particularly for exploration programs.

9.3.4.2 Residual Environmental Effects Assessment

Project-related drilling wastes such as cement, drilling fluids and cuttings are discharged to the seabed during the drilling of the riserless sections, and will accumulate in the vicinity of the wellhead, far below the maximum diving range of any seabird. They will therefore not interact with marine-associated birds and their habitats. Water depths in the Project Area range from approximately 300 m up to 1,200 m. Thick-billed Murres, the deepest-diving seabirds found in the Project Area, rarely reach depths of 200 m (Gaston and Hipfner 2000). Once the riser is installed, cement and cuttings will be discharged just below the MODU (below the surface of the water), in accordance with regulatory requirements and authorizations.

As also described in Chapter 2, SBM is recovered, reconditioned and reused until it is spent and then returned to shore for re-use or disposal at an approved facility. Surplus cement associated with riserless drilling (if any) will be discharged at the seabed, while cement returned to the MODU is disposed of in accordance with regulatory requirements and authorizations. SBM has a synthetic base fluid as a component, but SBM cuttings are treated prior to discharge, and have only a very small (and allowable)

fraction of residual SBM when discharged. Discharging the SBM-associated drill cuttings below the water's surface further mitigates the potential for marine and migratory birds to come into direct contact with the chemical components of SBM. With appropriate screening and selection of chemicals (including use of lower toxicity drilling fluids where technically feasible), and proper disposal of drill fluids and cuttings, direct effects on birds due to disposal of drill fluids and cuttings and associated waste materials are considered very unlikely.

Other potential liquid discharges from offshore vessels and equipment relate to the possible release of oily water and other substances through deck drainage, bilge water, ballast water, liquid wastes and produced water. These will again be managed through strict adherence to applicable environmental regulations and standards; for example, deck drainage and bilge water will be processed through an oil/water separator, and any liquid wastes that do not meet the targets outlined in the OWTG will be stored and transported to shore for disposal in an approved facility. Any seawater used for cooling pumps will be treated through an oil-water separator before being discharged at sea.

Atmospheric emissions associated with the Project include exhaust from power and heat generation from the MODU(s) and support vessels / helicopters, as well as emissions from hydrocarbon storage and flaring. With the implementation of appropriate mitigation measures as outlined in the atmospheric environment VC (Chapter 14), it is unlikely that such emissions will have any detectable effect on marine and migratory birds, as the emissions will be within regulatory standards, transient in nature, and short -term at any one location.

Any release of inorganic wastes may result in harmful effects through ingestion or entanglement, while generation and discharge of organic wastes can attract birds, increasing the potential for interactions with the Project. Any effects to the fish species upon which avifauna depend may also indirectly affect birds (Chapter 8). However, inadvertent release of wastes is considered unlikely to occur with adherence to appropriate standards. All solid and domestic waste will be collected from the MODU(s) and support vessels, and waste materials will be separated and recycled where possible. Solid waste will be stored in dedicated waste receptacles and collected dockside by an approved waste contractor for disposal at an existing and approved waste disposal facility; non-hazardous industrial waste will be directed to an approved municipal waste disposal site, while hazardous waste will be sent to an approved hazardous waste collection contractor. Waste food and sewage will be macerated and discharged overboard after treatment, in accordance with the OWTG and MARPOL, where it is expected to be quickly degraded by bacteria and other biological activity after release (BP 2016). These accepted waste management practices will be employed throughout the life of the Project, including implementation of a Waste Management Plan, adherence to the OWTG and MARPOL and compliance with the Transportation of Dangerous Goods Act, as applicable. Discharge of organic wastes (sewage and food scraps) may result in enhancement of the local food supply and attraction of birds to vessels and platforms, but this potentially positive effect may be offset by increased exposure to risk of collision / strandings or predation as well as energetic costs due to deviation from normal movement/migration patterns. This effect will, however, be short to medium term in any one location and very localized in nature. Implementation of accepted waste disposal practices will reduce any such effects of discharges of organic waste on birds.

With the implementation of mitigation measures summarized in Section 9.3.2 the overall magnitude of any effects of drilling and other marine discharges on marine and migratory birds (if they do occur) are

anticipated to be negligible, localized, of short-term duration, occurring sporadically (if at all), and reversible. These predictions are made with a high degree of certainty.

9.3.5 Vertical Seismic Profiling

VSP surveys employ a string of receivers placed down a well, with a sound source (usually mid-sized seismic source arrays) suspended from the MODU, or towed from a vessel and activated at pre-determined distances (in a "walk-away" VSP survey). The main environmental interactions and changes resulting from these Project components and activities are associated with underwater noise and vessel traffic (the latter of which is discussed further in Section 9.3.8).

9.3.5.1 Overview of Potential Effects and Existing Knowledge

There have been no known studies that have tested the levels of sound that cause injury to marine birds, although temporary hearing impairment can occur in avifauna that are exposed to sound in air (Saunders and Dooling 1974). The available evidence suggests that the underwater hearing of birds is poorer than in air, since the middle ear of birds constricts under the increased pressure associated with diving (Dooling and Therrien 2012). In addition, birds can regenerate sensory hair cells in the ear following damage due to noise exposure (Dooling and Popper 2007). Unlike certain other marine animals, seabirds are not known to communicate vocally underwater; for this reason, a heightened auditory sensitivity in water is thus unlikely to have developed. Studies have found that avian species vary in their susceptibility to hearing damage due to noise exposure (Ryals et al 1999); however, they appear to be generally more resistant to damage than mammals (Dooling and Popper 2007).

Bird species that forage underwater, particularly deep-diving birds such as the alcids, may be at somewhat higher risk of injury or disruption due to exposure to underwater noise generated by seismic arrays. Alcids dive from a resting position on the water in search of small fish and invertebrates, and are capable of reaching depths of between 20 to 60 m, where they may spend up to 40 seconds at a time (Gaston and Jones 1998). Unlike fish or marine mammals, which typically remain underwater, diving birds place their heads under the water suddenly in pursuit of prey. They may therefore be suddenly exposed to high noise levels without the benefit of a steady gradient or associated ramp up procedures. This interaction may be further accentuated by the attraction of many bird species to offshore vessels and platforms (as discussed above). Permanent physiological damage, namely hearing loss (acoustic threshold shift), is unlikely to result from seismic arrays. As discussed above, birds may be less susceptible to permanent hearing loss, and although low-frequency sound waves propagate further than higher frequencies, they are less damaging. However, temporary auditory damage from exposure to loud impulse noise may last days (Hashino et al 1988), which may have short term behavioural consequences (e.g., individuals may be unable to locate kin at nest sites).

There have not been studies showing substantial behavioural effects of underwater sound (e.g. large-scale and persistent avoidance behaviour), including seismic sound, on birds (Davis et al 1998; MMS 2004). Stemp (1985) reported that shearwaters have been observed close to a seismic sound array with their heads underwater, with no overt behavioural response. No changes in movements or diving behaviour of moulting Long-tailed Ducks in the Beaufort Sea was found during seismic surveys, although it is noted that smaller-scale behavioural changes, such as diving and movements of a short distance, could not be ruled out based on the study design (Lacroix et al 2003; Flint et al 2003). In the Davis Strait, Stemp (1985) studied effects of seismic surveys on the Thick-billed Murre, Northern Fulmar

and Black-legged Kittiwake and found no evidence of effects on mortality or distribution. Research in the Irish Sea also indicated no evidence that seabirds were attracted to or repelled by offshore seismic survey activity (Evans et al 1993).

9.3.5.2 Residual Environmental Effects Assessment

VSP surveys using 2D seismic arrays or other equipment will be conducted as part of the Project as required. However, these will be short-term (1 to 2 days per well) and localized in nature, and marine and migratory birds are unlikely to be adversely affected by the underwater sound energy associated with these activities beyond potential short-term disturbances of birds in the immediate vicinity of the activity. As illustrated above, there is little or no evidence that marine birds are adversely affected by marine geophysical surveys, particularly the underwater sound energy that is associated with these exploration activities. Because VSP seismic pulses are directed downward (into the well) and highly attenuated at the surface, the potential for birds feeding underwater to be exposed to sound levels that would result in mortality or injury is low. Above the water, the sound is reduced to a muffled shot that should have little or no effect on birds that have their heads above water or are in flight. At close range, birds on the water could potentially be startled by the sound, although the presence of the MODU and associated support vessels would likely have already alerted birds to unnatural visual and auditory stimuli. The very localized and short-term nature of these underwater disturbances at any one location and time during the program considerably reduces the potential for individuals and populations to be affected through injury or disturbance / avoidance. Many of the deep-diving birds that may be somewhat more likely to interact with such underwater noise, including murres and dovekies, are most common off Eastern Newfoundland during the winter months (November to February). It is very unlikely that non-diving marine species within the Study Area, such as gulls, shearwaters and storm-petrels, would be affected by these activities and the underwater noise that they generate.

Effects of noise disturbance on the nesting or foraging behaviour of surface-feeding seabirds are also very unlikely. As stated previously, the above-water noise levels of VSP sound sources are minimal. Because the Project activities (especially, well drilling and associated activities) will be over 400 km offshore, birds at nesting colonies and other coastal locations, including IBAs, are extremely unlikely to be exposed to noise or other disturbances from these activities. Although diving species such as alcids and Northern Gannets, as well as pursuit plungers such as shearwaters, spend some amount of time below the water surface, sound is not believed to be important for seabirds in securing food, and available evidence suggests that avian hearing is relatively poor underwater and is unlikely to be permanently damaged by seismic sound. Underwater noise from such surveys may adversely affect surface-feeding and diving seabirds indirectly, through potential changes in the presence, abundance or concentration of prey and potential displacement from key foraging areas. As described in Chapter 8, however, extensive and persistent changes to fish resources are not expected to occur as a result of the Project, and so changes in the availability, location or quality of food sources for marine birds are not predicted.

The potential environmental effects of such survey activities are related to noise exposure from VSP testing. These effects are predicted to be potentially adverse (if they do occur) but negligible in magnitude, localized, short-term, sporadic in frequency, and reversible, with a high level of certainty.

9.3.6 Well Testing

Well flow testing may occur during drilling of the well, or it may be carried out at a later date upon re-entering a suspended well, and flaring will be required as a component of flow testing. Flaring is the primary mechanism of interaction between well flow testing and marine and migratory birds. As described in Section 2.5.2.4, well testing activities would likely be required and conducted at only a portion of the wells drilled as part of this Project

9.3.6.1 Overview of Potential Effects and Existing Knowledge

In Atlantic Canada, nocturnal migrants and night-flying seabirds such as Leach's Storm-petrels are the migratory birds most at risk of attraction to flares, although the severity of such interactions is poorly known. Available estimates often rely on recovery of birds on platforms and vessels, and it is not known how many birds are killed but not recovered due to scavenging or landing in the ocean (Bruinzeel et al 2009; Ellis et al 2013). Surveys of bird attraction to a flare were conducted on an offshore production platform in the North Sea (Hope Jones 1980), and it was reported that seabirds were attracted to the flare (mainly fulmars and gulls), feeding directly below it. A single bird was observed flying up near the flame during the five-week observation period, and no bird mortality as a result of the flare was observed. The author stated that mortality had been reported from gas flares elsewhere in the North Sea, but typically in low numbers.

Similar to offshore lighting, a number of factors influence the potential severity of marine bird interactions with flares such as the time of year and location (both of which influence whether concentrations of birds are present near the flare), stack height, and weather conditions (Weir 1976; Wiese et al 2001). Mortality can increase during migration, particularly when poor weather conditions force birds to fly relatively low (Wiese et al 2001). Time of night can also have an influence (Weir 1976), in that the risk of mortality due to flares and other artificial lights may be higher in the latter part of the night, as most nocturnal migrants climb to their migrating height soon after dark and then undertake a gradual descent shortly after midnight.

9.3.6.2 Residual Environmental Effects Assessment

Any flaring events conducted during the Project will occur over 400 km offshore. This is far away from coastal breeding sites and IBAs and well beyond the foraging range of almost all species that nest in Newfoundland, with the exception of the Leach's Storm-petrel which may forage thousands of kilometres from the nest site during the breeding season (Pollet et al 2014). Therefore, breeding birds are unlikely to be affected by this activity, with the possible exception of the Leach's Storm-petrel. As with other artificial nocturnal lighting, there is slight potential for the attraction of migratory landbirds, particularly during the fall months when landbird migration is taking place and unfavorable weather conditions are most frequent. However, most migrating landbirds tend to fly closer to land (Weir 1976; Blomqvist and Peterz 1984), and so it is unlikely that large numbers of landbirds will be affected by Project activities over 400 km offshore.

Mitigation measures regarding flaring will be adhered to throughout the Project, including minimizing the number and duration of any flaring events, the use of high efficiency burners and, where technically feasible, consideration of additional recommendations provided by ECCC-CWS regarding offshore flaring (including avoidance of flaring near concentrations of birds and during weather conditions that

may enhance attraction). In any event, any required well testing activities (including flaring) will be short in duration (up to several days), and any associated bird attraction will be limited to within approximately five kilometers of the MODU (Poot et al 2008).

The potential environmental effects of well testing (including flaring) are primarily related to attraction of birds to flares. Any such effects are predicted to be adverse, low in magnitude, localized and within the LSA overall, of short-term duration and sporadic in frequency, and will be reversible. These effects predictions are made with a high level of certainty.

9.3.7 Well Abandonment or Suspension

Well abandonment and suspension activities are conducted below the mudline (placement of cement plugs in the well) and just above the mudline (recovery of casing / wellhead); further, approval may be sought to leave the wellhead in place on the seabed. Wells will be abandoned or suspended in adherence to the requirements set out under the *Newfoundland Offshore Petroleum Drilling and Production Regulations.* These activities will be occasional and of short duration at any one location. Further, they will be conducted well below diving depths for even the deepest-diving seabirds; water depths in the Project Area range from approximately 300 m to over 1000 m, whereas Thick-billed Murres (the deepest-diving seabirds found in the Project Area) rarely reach depths of 200 m (Gaston and Hipfner 2000). Presence and operation of the MODU and associated supply and servicing vessels will be associated with well suspension and abandonment operations; effects of these are discussed in Sections 9.3.3 and 9.3.8, respectively. However, no additional effects on marine and migratory birds as a result of well abandonment or suspension are anticipated.

The predicted environmental effects of well abandonment or suspension are related to associated presence and operation of the MODU and associated support vessels, as assessed previously. The conduct of these activities themselves are not expected to have any adverse effects on this VC.

9.3.8 Supply and Servicing

The offshore exploration program will involve support vessel and aircraft (presence and movements) traffic to, from, and within the Project Area at all times of year throughout the Project life. This traffic may affect seabirds through lighting, noise and other associated environmental emissions and discharges.

Overall, the various bird species that occupy the Project Area and LSA will not likely be disturbed by Project-related support vessel activity or any associated aircraft use due to its transitory nature and, thus, its immediate to short-term presence at any one location, and because the amount of traffic is generally in keeping with the overall marine traffic that has occurred throughout the region for years.

9.3.8.1 Overview of Potential Effects and Existing Knowledge

The potential effects of bird attraction to nocturnal artificial lighting sources in the offshore environment were discussed in Section 9.3.3, and the potential effects of discharges from Project-related MODUs and vessels are described in Section 9.3.4.

Aircraft use will be required for the Project at various times of year, throughout its duration. Offshore helicopter use is of particular relevance to the marine and migratory birds VC because helicopter activity and its associated noise can potentially disturb nesting seabirds at colonies. Flushing of breeding birds from the nest in response to loud noises, such as helicopter flights, can have immediate negative consequences including predation of eggs and chicks and decreased incubation and brooding (Burger 1981; Brown 1990; Bolduc and Guillemette 2003; Beale 2007; Burger et al 2010). Nestlings may also be vulnerable to exposure, and adults may inadvertently knock eggs and flightless young from the nest, which is of particular concern for cliff-nesting species such as murres and kittiwakes (Burger 1981; Carney and Sydeman 1999). Reduced foraging and provisioning rates may impact nestling growth and survival (Davis and Wiseley 1974; Lynch and Speake 1978; Belanger and Bedard 1990; Delaney et al 2002; Goudie 2006).

There is potential for disturbance effects resulting from aircraft overflights on birds, including temporary loss of useable habitat, increased energy expenditure (e.g. due to escape reactions / flushing, increased heart rate, lower food intake due to interruptions; see, for example, Ellis et al 1991; Trimper et al 2003; Komenda-Zehnder et al 2003). Noise may also deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure (Larkin 1996; Beale 2007). Reactions of marine birds to helicopters and other aircraft depends on factors such as the species and previous exposure levels of individuals (i.e. degree of habituation), as well the location, altitude and frequency of flights (Hoang 2013). Research has shown that overt behavioural responses to helicopter traffic, such as flushing, may occur at a distance of over 350 m for Common Murres (Rojek et al 2007), although there is inherent variability in behavioural responses between and even within species (Blumstein et al 2005; Hoang 2013).

9.3.8.2 Residual Environmental Effects Assessment

Potential effects due to lighting on support vessels are anticipated to be similar to those resulting from lighting on the MODU (Section 9.3.3), although vessel traffic will not be stationary, meaning that any disturbances will be transient in nature but will extend across a wider area along the identified vessel traffic route(s), including areas closer to shore, which increases potential for attraction of night-flying landbirds during fall migration. However, mitigation measures will be in place during Project operations to reduce the effects of bird attraction due to offshore lighting (see Section 9.3.3). Further, the presence of Project-related vessels would be a negligible addition of night lighting in the Eastern Newfoundland Offshore Area, considering the volume of fishing boats, commercial traffic and other vessels within the region year-round (Section 7.2, 7.3)

Environmental disturbances and effects due to emissions and discharges from vessels will also be transient in nature. The release of organic wastes by offshore vessels and activities can attract birds, which may increase the potential for interactions including risk of predation, collision and exposure to contaminants. However, proper waste management practices and adherence to associated MARPOL requirements will minimize these potential effects (e.g., food and sewage waste will not be discharged within three nautical miles of the coast). Other potential environmental discharges from offshore vessels and equipment relate to the possible release of oily water and other substances through deck drainage, bilge/ballast water, open drains, sanitary waste/grey water, and other hazardous/non-hazardous wastes. The potential effects of such discharges on marine-associated birds are detailed in Section 9.3.4. These will be managed through strict adherence to applicable environmental regulations and standards, and each of the vessels involved in this Project will use, store and handle fuels, oils and

other such materials in an environmentally acceptable manner in accordance with applicable regulations and standards (Chapter 2).

Overall, any interactions between Project-related supply and servicing activities and bird species are anticipated to be minor due to the relatively routine, localized, short- to medium-term and transitory nature of these activities, and because it is generally in keeping with the overall marine traffic that has occurred throughout the region for decades. Project-related support vessel traffic will avoid known seabird colonies in accordance with the *Seabird Ecological Reserve Regulations, 2015*, and will utilize existing and established routes wherever possible. Support vessel traffic is estimated at 2 to 3 return transits per week for a single MODU; for two MODUs, an average of 4 to 5 return transits per week is anticipated. This represents a negligible contribution to the overall vessel traffic off Eastern Newfoundland, as discussed in Chapter 2.

Helicopters will be used for crew transfers and other purposes as required, and 1 to 3 return transits per day are anticipated for a single MODU, while 2 to 6 transits per day may be required if two MODUs are being used simultaneously. Additional helicopter trips may be required (e.g., transportation of required technical personnel, parts or equipment, or removal of a crew member in an emergency situation), but these are anticipated to be infrequent. Further, helicopters will avoid coastal seabird colonies during the nesting season as per the *Seabird Ecological Reserve Regulations*, *2015*, i.e. by not taking off or landing in, and by flying at an altitude of greater than 300 m over seabird ecological reserves during sensitive times of year to avoid disturbance. For Cape St. Mary's and Baccalieu Island Ecological Reserves for example, this avoidance period is from April 1 to October 30; for Witless Bay Islands Ecological Reserve, the period is from April 1 to September 1, and for the Lawn Bay Ecological Reserve, the period is from March 15 to October 30. Known colony locations are shown in Section 6.2.7. Potential interactions with and adverse effects on coastal breeding colonies and IBAs are therefore unlikely.

In accordance with standard practices, vessels and aircraft will transit in a straight line approach from the shore based facility (unless the presence of pack ice or other environmental phenomena requires routes to be altered), and thus, the amount of time these are near coastal habitats will be minimized. The amount of helicopter traffic will be minimized for the Project, and low-level aircraft operations will be avoided to the degree possible. Known and observed bird colonies, significant aggregations of avifauna, critical habitats and protected or sensitive areas and times will also be avoided wherever possible.

During offshore Project operations, routine searches of support vessel and MODU decks will be undertaken. Collection and release of any birds that become stranded will be implemented by qualified and experienced personnel, in accordance with applicable protocols, regulatory guidance and requirements, as well as the ECCC-CWS bird handling permit.

In summary, the predicted environmental effects of supply and servicing activities are predicted to be adverse, low in magnitude, localized, short-term, sporadic in frequency, and reversible, with a high level of certainty.

9.4 Species at Risk: Overview of Potential Effects and Key Mitigation

The potential environmental interactions between the Project and any avian SAR, and the planned and proposed mitigation measures to avoid or reduce any such adverse interactions, are the same as those for the marine and migratory bird VC as a whole. Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these species at risk is provided in the Table 9.3 below.

Table 9.3 Marine and Migratory Bird Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	*NL ESA*	*SARA*	COSEWIC	Summary of Presence and Potential Interactions
Barrow's Goldeneye (Eastern pop.)	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Moults and winters in small numbers off the coast of Eastern Canada. • Known to congregate in relatively small geographic areas in important shipping corridors, therefore considered to be particularly vulnerable to being affected by accidental spills (Schmelzer 2006). • Unlikely to be present in Project Area due to their preference for coastal habitats.
Harlequin Duck (Eastern pop.)	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Breed inland, but occur in the coastal marine environment throughout the fall and winter months. Some non-breeding individuals may be found year-round at Cape St. Mary's. • Unlikely to be present in Project Area due to their preference for coastal habitats.
Ivory Gull	Endangered	Endangered (Schedule 1)	Endangered	• Breeds in the far north and winters offshore; found in small numbers in the waters off Eastern Newfoundland, typically among pack ice. • Potentially present. Ivory Gulls are most likely to occur in areas of pack ice; refer to Section 5.6.1 for pack ice extents in the Project Area. No critical habitat for the species exists in the Project Area.
Red-necked Phalarope	none	none	Special Concern	• Phalaropes come onshore only to breed, and occur in the coastal marine environment the rest of the year.

Species	*NL ESA*	*SARA*	COSEWIC	Summary of Presence and Potential Interactions
				• Surface feeders, often congregating in areas such as upwellings which are associated with higher prey densities. • Present in small numbers off Eastern Newfoundland, although scarce in the winter and spring (ECSAS 2016).
Piping Plover (*Melodus* ssp.)	Endangered	Endangered (Schedule 1)	Endangered	• During the nesting season, Piping Plovers are found on sandy beaches along the coast. In Newfoundland, breeding population is concentrated in the southwest and western portions of the Island. • Piping Plovers are unlikely to be affected by planned Project activities due to their preference for coastal habitats.
Red Knot (*Rufa* ssp.)	Endangered	Endangered (Schedule 1)	Endangered	• Arctic breeders. Newfoundland is not considered to be a major migratory stopover location; nonetheless, sightings have been reported around much of coastal Newfoundland. • Unlikely to be present in Project Area due to their preference for coastal habitats.
Buff-breasted Sandpiper	none	none	Special Concern	• Arctic breeders. Newfoundland is not considered to be a major migratory stopover location; nonetheless, sightings have been reported in parts of coastal Newfoundland. • Unlikely to be present in Project Area due to their preference for coastal habitats.
Peregrine Falcon	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Migrates along the coast of Newfoundland during the fall (particularly the west coast), preying on concentrations of migrating shorebirds. • Some evidence suggests they may be attracted to platforms due to the abundance of prey species. • Unlikely to occur regularly in Project Area due to their preference for coastal habitats.

Species	*NL ESA*	*SARA*	COSEWIC	Summary of Presence and Potential Interactions
Common Nighthawk	Threatened	Threatened (Schedule 1)	Threatened	• Not known to breed in insular Newfoundland although it is regularly seen. Unlikely to occur regularly in the Project Area.
Gray-cheeked Thrush (*minimus* ssp.)	Threatened	none	Candidate Species (low priority)	• Unlikely to be found in the Project Area as it is an inland species. • However during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment.
Olive-sided Flycatcher	Threatened	Threatened (Schedule 1)	Threatened	• Unlikely to be found in the Project Area as it is an inland species. • However during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment.
Bobolink	Vulnerable	none	Threatened	• Unlikely to be found in the Project Area as it is an inland species and uncommon in Eastern Newfoundland. • However during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment.
Short-eared Owl	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Typically nests in coastal barrens and grasslands, and suitable habitat occurs in much of coastal Newfoundland. • Unlikely to be present in Project Area due to their preference for coastal habitats.

There is no designated Critical Habitat for avian species at risk in or near the Project Area and LSA. The only marine-associated avian species at risk that have potential to occur regularly in the Project Area / LSA are the Ivory Gull and Red-necked Phalarope. Ivory Gull spends most of its time on pack ice in the winter months, and therefore is less likely to come into contact with low-level hydrocarbon discharge than species that spend more of their time on the water; conversely, phalaropes spend most of their time on the water's surface. Both Ivory Gull and Red-necked Phalarope may be attracted by increased food availability from organic wastes generated by the MODU and support vessels. However, these species are not known to be susceptible to disorientation by artificial light sources.

During fall migration, there is slight potential for Peregrine Falcons to be attracted to platforms because of the increase in prey availability, as they are attracted to flocks of migrating birds, and some nocturnally migrating landbird species at risk may be attracted by the lighting. However, because operations will be situated over 400 km from shore, these landbird species are unlikely to occur in the Project Area / LSA. Lighting from support vessel traffic closer to shore may attract / disorient migrating landbirds, including species at risk.

As a result of the above analysis, and with the implementation of the various mitigations outlined in Sections 9.3.2 the Project is not considered likely to result in adverse effects upon avian species at risk. The Project will not affect critical habitat for any of these species, nor is it likely to result in disturbance of coastal breeding colonies given its offshore location.

9.5 Environmental Effects Evaluation

This section summarizes the residual (after mitigation) effects of the Project on marine and migratory birds (including avian species at risk) and presents a determination of significance for the environmental effects assessment for this VC.

9.5.1 Residual Environmental Effects Summary

As described above and summarized in Table 9.4 below, with the implementation of the various mitigations outlined in the preceding sections, the Project is not likely to result in adverse environmental effects on marine and migratory birds. (including species at risk) The presence and operation of the MODU, drilling and associated marine discharges, VSP surveys, well testing (including flaring), well abandonment or suspension and supply and servicing activities may result in adverse effects on avifauna, primarily through platform and vessel attraction associated with lighting and other potential environmental interactions and emissions leading to some increased potential for changes in individual bird mortality / injury (particularly in the spring and fall migration periods and during specific meteorological conditions) or other effects. However, these will be avoided or reduced through the various mitigations identified herein, and are not predicted to result in population level effects.

The Ivory Gull and Red-necked Phalarope are the only avian species at risk that are likely to be found regularly in the Project Area and surrounding LSA. The former is typically found on pack ice, while the latter is fairly widespread associated with areas that have higher density of food, such as upwellings. Neither species is known to be especially prone to disorientation effects from artificial lighting, although there is potential for attraction due to increased foraging opportunities. As stated in Section 9.4, the Ivory Gull spends most of its time on pack ice in the winter months, and therefore is less likely to come into contact any potential with low-level hydrocarbon discharge than species that spend more of their time on the water. Phalaropes spend most of their time on the water's surface and so may be vulnerable to this interaction. During fall migration, there is some potential for predatory Peregrine Falcons and nocturnally migrating landbird species at risk to be attracted to the Project, but due to the large distance of the Project Area from shore, the presence of these species is not expected.

Table 9.4 Environmental Effects Assessment Summary: Marine and Migratory Birds

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *	
Summary of Existing Conditions and Environmental Context • A variety of avifauna species occur within the marine and coastal environments off Eastern Newfoundland at various times of the year, including seabirds and other avifauna that inhabit the region at particular or extended periods for breeding, feeding, migration and other activities according to their individual life histories and habitat requirements. • A number of important habitats for birds have also been identified at locations along the coastline of Newfoundland and Labrador, well outside of the area within which exploration drilling and associated activities are planned to occur.	**Key Mitigation Measures (See Section 9.3.2)** • Minimizing and managing discharges/emissions from Project activities, and compliance with applicable regulations and guidelines. • Nexen will operate in accordance with the *Measures to Protect and Monitor Seabirds in Petroleum-Related Activity in the Canada-Newfoundland and Labrador Offshore Area.* • Where possible, known and observed bird colonies, other significant aggregations of avifauna, and other identified sensitive areas will be avoided in the conduct of Project-related exploration activities. • The frequency of vessel and aircraft traffic transits associated with the Project will be minimized to the extent possible. • Project-related artificial lighting will be minimized to the greatest extent possible without compromising safety. • Flaring will be kept to the minimum amount necessary to characterize the hydrocarbon accumulation and as necessary for the safety of the operation. High efficiency burners will be used, and the Project will consider flare shields if technically and safely feasible. • Routine searches for stranded birds will be conducted on the MODUs and supply vessels, and appropriate programs and protocols for the collection and release of marine and migratory birds will be implemented for any birds that become stranded. • Nexen will obtain the necessary Seabird Handling Permit from ECCC-CWS.

Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance (behavioral effects)	A	L	L-LSA	S-M	R	R	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
	• Change in habitat availability and quality • Change in food availability or quality							
Drilling and Associated Marine Discharges (including fluids and cuttings)	• Change in mortality / injury levels and bird health • Change in food availability or quality	N-A	N	L	S	S	R	H
Vertical Seismic Profiling	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance (behavioral effects) • Change in food availability or quality	N-A	N	L	S	S	R	H
Well Testing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance (behavioral effects)	A	L	L-LSA	S	S	R	H
Well Abandonment or Suspension	• None expected	N	-	-	-	-	-	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
Supply and Servicing	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance (behavioral effects)	A	L	L	S	R	R	H

Evaluation of Significance

Not Significant

- The Project is not likely to result in significant effects on marine and migratory birds.
- Project-related emissions and attraction due to lighting and flaring may result in some mortality and injury of individuals, particularly Leach's Storm-petrels, but are unlikely to have overall effects on populations. Nocturnally migrating landbirds may be attracted to offshore lighting, particularly supply and servicing vessels closer to shore. Any such effects will be minimized through implementation of appropriate mitigation measures.
- The Project is unlikely to result in significant effects involving marine-associated avian species at risk. Ivory Gull and Red-necked Phalarope are the only avian species at risk that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and other nocturnally migrating landbird species at risk to be attracted to the Project, particularly to the MODU and support vessels, but the risk of interactions will be minimized with appropriate mitigation measures.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

9.5.2 Determination of Significance

The Project will not result in significant adverse environmental effects on marine and migratory birds. This conclusion has been determined with a moderate to high level of certainty based on the nature and scope of the Project, knowledge about the existing environment within the LSA and RSA, and current understanding of the observed effects of similar projects on the VC. The primary mechanisms of interaction that may have adverse effects on this VC include platform and vessel attraction associated with lighting and increased foraging opportunities, and any routine discharges from offshore platforms and vessels (such as organic wastes). While these interactions may lead to increased potential for mortality or injury of individuals, the disturbances (and thus, any predicted effects) are anticipated to be negligible to minor and spatially and temporally limited, and thus number of individuals potentially affected by the Project is not anticipated to have any overall ecological or population-level effects.

The Project will not result in significant adverse environmental effects involving marine-associated avian species at risk and their habitats. The Ivory Gull and Red-necked Phalarope are the only avian species at risk that are likely to be found with any regularity in the Project Area, and could potentially be attracted by increased foraging opportunities associated with the MODU and support vessels. However, a review of the literature did not indicate these species to be particularly susceptible to disorientation due to artificial lighting.

9.6 Environmental Monitoring and Follow-up

Nexen will develop and implement an operational monitoring program for marine birds throughout the course of the Project. A trained Environmental Observer will be onboard the MODU to record marine bird (and marine mammals) sightings during Project operations, which will be undertaken in accordance with the Canadian Wildlife Service's pelagic seabird monitoring protocol (Gjerdrum et al 2012), and will utilize other available information and sources, including the guide for pelagic seabirds of Atlantic Canada. A report of the seabird monitoring program, together with any recommended changes, will be submitted to the C-NLOPB and CWS on a yearly basis in the format recommended by the regulator.

During Project operations offshore, regular searches of vessel decks will be undertaken and accepted protocols for the collection and release of any birds that become stranded will be implemented by qualified and experienced personnel, in accordance with applicable regulatory guidance and requirements and the ECCC-CWS bird handling permit.

No specific follow-up related to the marine and migratory birds VC is considered necessary in relation to the Project.

9.7 References

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10 MARINE MAMMALS AND SEA TURTLES: ENVIRONMENTAL EFFECTS ASSESSMENT

The waters off Eastern Newfoundland support a diverse assemblage of marine fauna throughout the year. As described in Section 6.3, over 20 marine mammals and five sea turtle species have been reported in the region, including several that are considered to be at risk or otherwise of special conservation concern.

Marine mammals and sea turtles are often considered to be ecologically, economically, culturally, and/or recreationally important, and these species and their habitats are managed and protected under the federal *Fisheries Act* and *Species at Risk Act* (SARA). The *Fisheries Act* includes provisions that prohibit serious harm to marine animals, including marine mammals and sea turtles, that are part of a commercial, recreational or Aboriginal fishery. SARA includes provisions to protect species listed on Schedule 1 of the Act as well as their identified and designated critical habitat. This VC integrally considers species that are considered to be stable, as well as those considered to be at risk under SARA and other species that are otherwise considered to be of special conservation concern, such as by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). A number of Ecologically and Biologically Significant Areas (EBSAs) have also been identified by DFO off Eastern Newfoundland often in part because of their importance to marine mammals in terms of biodiversity, density and importance for reproduction and survival (Section 6.4). There is currently no designated critical habitat for marine mammals or sea turtles in or near the Project Area.

As marine mammals and sea turtles use marine habitats in a similar way, and because the nature of their potential interactions with planned Project components and activities is similar, these species groups are assessed together as part of this VC, with any key differences noted where applicable.

10.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

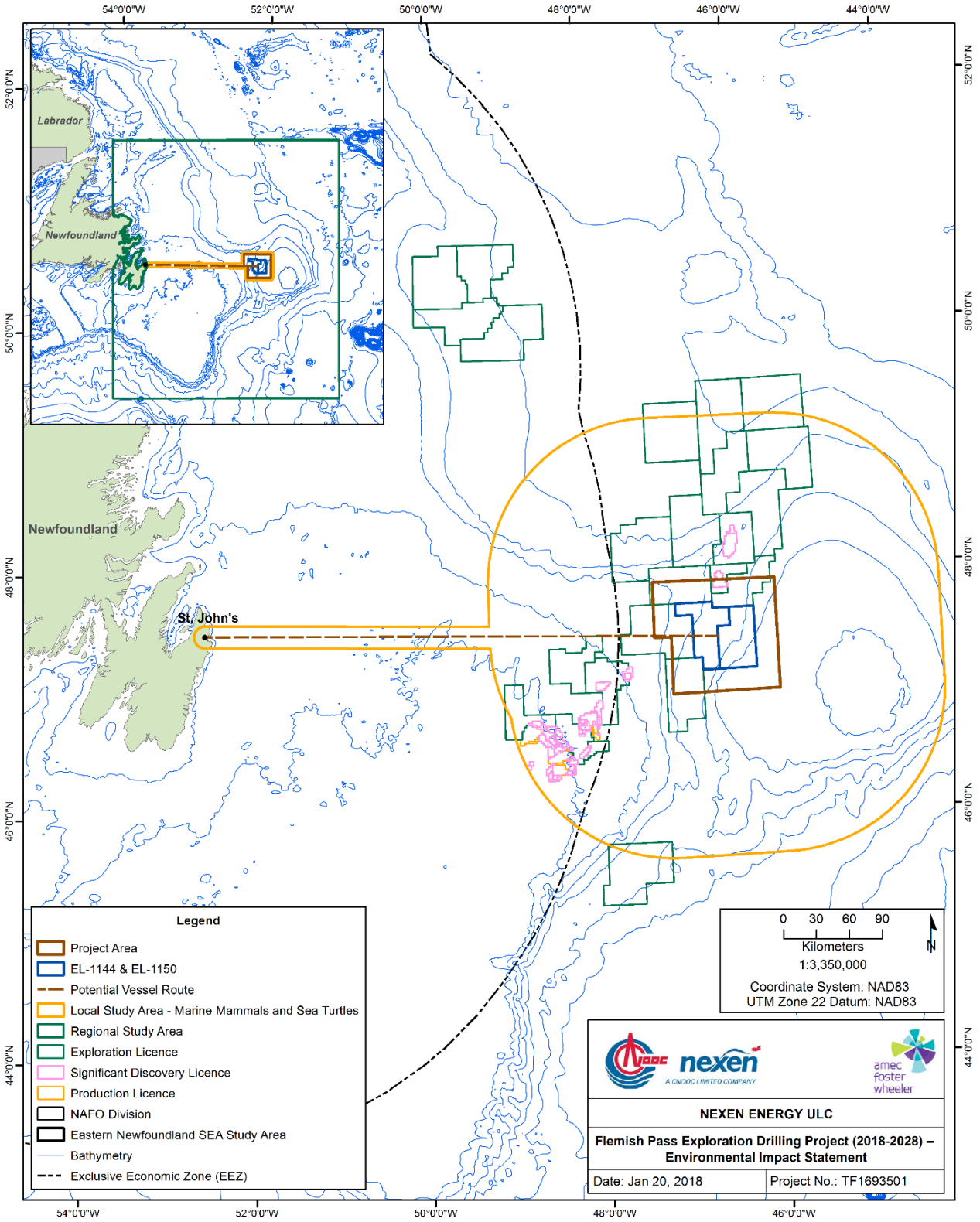
This section defines the EA Study Areas (spatial and temporal boundaries) for the environmental effects assessment for this VC.

10.1.1 Spatial Boundaries

Spatial assessment boundaries have been defined for the environmental effects assessment for this VC to reflect the varying ways and scales in which the Project may influence marine mammals and sea turtles and their habitats. These are defined as follows and depicted in Figure 10.1.

Project Area: This area encompasses the overall geographic area offshore Eastern Newfoundland within which all planned Project-related exploration activities will take place. This includes ELs 1144 and 1150, within which drilling will occur, as well as a surrounding 20 km buffer area to account for any ancillary activities (such as walk away VSP surveys) that may extend outside the boundaries of the ELs themselves. While the Project Area is defined as an overall polygon that encompasses all such activities over the course of the Project, the various activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply vessel and aircraft traffic to and from this offshore Project Area.

Figure 10.1 Marine Mammals and Sea Turtles: Environmental Assessment Study Areas



Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's components and activities, and therefore, encompasses the overall geographic area over which all planned Project-related environmental interactions (including any emissions and other disturbances) are predicted to occur. As described in this chapter, the main Project-related environmental emissions and interactions that may affect marine mammals and sea turtles are the underwater noise that may be generated by the active MODU(s) and support vessels and sound from any VSP as well as emissions from routine Project activities (eg, grey and black water). While such interactions between planned Project components and activities and marine mammals and sea turtles are expected to occur primarily within the overall Project Area polygon defined above, as described in this chapter the effects of underwater noise could extend out considerable distances from the source. As a result, the LSA is therefore (conservatively) defined as the Project Area and an approximately 150 km area around it, as well as an approximately 10 km area around the associated support vessel and aircraft traffic route to the ELs.

Regional Study Area (RSA): In addition to Project- and disturbance-related factors, from an ecological perspective the environmental effects assessment also recognizes and considers the particular characteristics, distributions and movements of the individual VCs under consideration, including the larger regional areas within which they occur and function. Ecological boundaries for marine mammals and sea turtles vary between species due to difference in their ranges, habitat preferences, movement patterns and key activities. The EA assesses potential effects to marine mammals and sea turtles (individuals and populations) that are known or likely to use the LSA, and considers the overall extent of any affected individuals and populations over the time period at which they may be affected by planned Project components and activities. Key aspects of marine biota movements and distributions as they relate to the Project Area and LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this chapter) and cumulative (Chapter 15) effects upon this VC. The overall RSA for the environmental effects assessment is as defined and illustrated earlier in Section 4.3.

10.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the potential duration of Project-related activities in the Project Area (2018-2028, see Section 2.7), as well as the likely timing of any resulting environmental effects. In conducting the assessment, special consideration is also given to timing of VC presence within the Project and Assessment Areas, including any particularly important or sensitive periods. Section 6.3 provides details of marine mammal and sea turtle species known to occur within these areas, as well as the known timing of their presence.

10.1.3 Environmental Effect Significance Definitions

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects on this VC and their significance are assessed and evaluated.

Significant environmental effects on marine mammals and sea turtles are defined as those that would cause one or more of the following:

- *A detectable decline in overall marine mammal or sea turtle abundance or change in the spatial and temporal distributions of populations within the overall RSA over multiple generations*

- *Effects to a designated (protected) species at risk such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected*

10.2 Potential Environmental Changes, Effects and Associated Parameters

The key potential environmental interactions between planned Project activities and marine mammals and sea turtles – including the associated Project-related environmental changes and possible resulting environmental effects on this VC – include the following (as summarized and adapted from Amec 2014):

- Possible temporary hearing impairment or permanent injury or mortality caused by exposure to loud underwater noise (such as from a seismic sound source used during VSP surveys) at or above identified threshold levels for the onset of injury.

- Potential injury or mortality due to collisions or other interactions with support vessels (including from associated attraction to vessels).

- Disturbance of marine mammals and sea turtles (behavioural effects) as a result of Project-related activities or equipment (including sound and other emissions). Behavioural effects may include alterations in the presence, abundance, and overall distribution of marine mammals and sea turtles as well as modifications to their movements, feeding, communication patterns and other activities.

- Interference with and the masking of sounds within the marine environment that originate from and/or are used by marine animals (communication, echolocation, identification and detection of predators/prey) as a result of Project-related underwater noise.

- Changes in the availability, distribution and/or quality of food sources or habitats for marine mammals and sea turtles due to emissions and other disturbances (noise, light, drilling fluids, other liquid and solid waste materials).

The EIS Guidelines also identify and specify a number of these issues and potential effects on marine mammals and sea turtles that require consideration in the EIS (Part 2, Section 6.3.3 and 6.3.4). These are listed in detail in the Table of Concordance included at the beginning of the EIS.

A number of questions and comments related to this VC were also noted during Nexen's Project-related consultations with government departments and agencies, stakeholder organizations and Indigenous groups. These include general concerns regarding the potential effects of Project-related underwater noise on marine mammals species, particularly those that are species at risk and of high cultural value (see Chapter 3 for further details).

The environmental effects assessment for this VC considers and focuses upon the various issues and questions identified through these various issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result. These are summarized in Table 10.1, along with the identification of a number of key parameters through which these Project-related changes and effects may be reflected.

Table 10.1 Potential Project-Related VC Environmental Changes and Resulting Effects: Marine Mammals and Sea Turtles

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• Offshore oil and gas related activities have the potential to result in mortality, injury or other sub-lethal health effects due to: - Increased underwater noise at or above published and/or industry standard thresholds in the marine environment, resulting in changes to the acoustic conditions in the affected areas. - Marine vessel traffic which has the potential to result in an increase in vessel strikes with marine mammals and sea turtles. - The introduction of contaminants (including hydrocarbons and drilling fluids during planned and routine activities) to the marine environment.	*Change in Mortality / Injury Levels and Health (Individuals or Populations)*	• Levels and extent of underwater noise, relative to known, applicable thresholds for onset of auditory injury in marine mammals and sea turtles. • Number and frequency of injuries or mortalities from Project-related vessel strikes. • Degree and extent of any changes to water and sediment quality from introduced contaminants. • Occurrence and success of key life history stages (e.g., feeding, reproduction) by any individuals affected by the Project. • Individuals and species present and overall species diversity in the LSA and RSA.
• Project-related activities (e.g., drilling, VSP, shipping) will introduce additional sources of underwater noise to the marine environment. • Exposure to underwater noise at or above published and/or industry standard thresholds has the potential to result in behavioral effects such as changes in activity, movement, or communication patterns in marine mammals and sea turtles. • Masking of communication and increased stress levels may also be observed. • Changes in the availability, extent and quality of habitats available to marine mammals and sea turtles have the potential to affect the health of individuals in the affected areas, as displacement from or loss of important habitats can, for example, result in increased energy expenditure.	*Change in Habitat Availability, Quality and Use (Behavioral Effects)*	• Levels and extent of underwater noise, relative to known, applicable levels that create behavioral affects in marine mammals and sea turtles. • Amount, extent and timing of altered habitats relative to their availability within the LSA and RSA.
• Project components and activities have the potential to alter the distribution, availability, health, or species composition of marine mammal and sea turtle prey (e.g. through disturbance, or by introduction of contaminants and organic wastes), which can	*Change in Food Availability or Quality*	• Prey availability and quality in the LSA and RSA

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
potentially affect the presence, abundance and health of marine mammals and turtles.		

An overview of the potential for each of the Project's planned components and activities to result in one or more of the above noted potential environmental effects on this VC is presented in Table 10.2.

Table 10.2 Potential Project-VC Interactions and Associated Effects: Marine Mammals and Sea Turtles

Planned Project Component / Activity	Potential Environmental Effects		
	Change in Mortality / Injury Levels and Health	Change in Habitat Availability, Quality and Use	Change in Food Availability or Quality
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●	●
Drilling and Associated Marine Discharges (including fluids and cuttings)	●	●	●
Vertical Seismic Profiling	●	●	●
Well Testing	●	●	●
Well Abandonment or Suspension		●	●
Supply and Servicing	●	●	●

10.3 Environmental Effects Assessment and Mitigation

The potential effects of the Project's planned components and activities on marine mammals and sea turtles are assessed and described in the following subsections. Mitigation measures to prevent or reduce adverse effects upon this VC are summarized at the onset in Section 10.3.2, and are considered in a fully integrated manner within the environmental effects analysis that follows, as applicable. The environmental effects assessment for unplanned (accidental) events for all VCs, including this one, is presented separately in Chapter 16.

10.3.1 Approach and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on the consideration of the nature, scale and timing of the Project's planned components and activities (Chapter 2), and the existing environment for this VC (Section 6.3). This analysis has focused first on identifying key potential Project-VC interactions, and any anticipated changes to the existing biophysical environment resulting from planned Project activities and emissions that may, through one or more

associated pathways, lead either directly or indirectly to overall effects on the presence, abundance, diversity, health or other aspects of marine mammals and sea turtles at the individual or population levels.

This assessment for marine mammals and sea turtles includes a review and summary of available literature and the incorporation of pertinent knowledge on these potential interactions to inform the effects analysis. Known and likely environmental issues and interactions regarding this VC are detailed in other sources such as the Eastern Newfoundland SEA (Amec 2014), the primary literature, and EAs conducted for similar oil and gas activities offshore Newfoundland and Labrador and elsewhere.

As noted in Section 6.3, detailed and complete datasets regarding marine mammals presence and distributions in the LSA and RSA are not available, and marine mammals and sea turtles are highly mobile with many species undertaking extensive seasonal migrations. Estimates of their densities and relative abundance specific to the boundaries of the Project Area, LSA or RSA therefore cannot be known in detail and made with complete certainty. Therefore, the assessment of the potential for interactions with and effects on this VC is of necessity based on a general understanding of species presence and distribution in the region, both spatially and temporally, based on available information sources such as opportunistic sightings for offshore Newfoundland obtained from DFO and the OBIS (Section 6.3). The effects assessment considers potential interactions with the various Project components and activities and any resulting effects while at the same time recognizing that the potential for and degree of any such interactions will vary and will depend on the actual occurrence of individuals within this geographic area at the particular times involved.

10.3.2 Summary of Key Mitigation

Key mitigation measures that will be implemented in relation to the Project to help avoid or reduce potential environmental effects on marine mammals and sea turtles include (see also Section 8.3.2):

a) Existing and common vessel travel routes will be used wherever practical, vessels will seek to maintain a steady course and vessel speed, and any low-level aircraft operations will also be avoided or minimized (except for approach and landing activities).

b) Nexen will minimize environmental discharges and emissions from planned operations and activities, and comply with relevant regulations and standards. Relevant operational discharges will be treated prior to release in compliance with the OWTG and other applicable regulations and guidelines, and oil-water separators will be used to treat contained oil contaminated fluids, with collected oil above discharge limits properly stored and disposed of.

c) Where technically feasible, lower toxicity drilling fluids will preferentially be used. Selection and screening of chemicals will be undertaken pursuant to the OCSG.

d) During any associated well testing, any produced hydrocarbons and small amounts of produced water will be flared using high-efficiency burners. If there is a significant amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge.

e) Appropriate measures for the handling, storage, transportation and on-shore disposal of solid and hazardous wastes will be employed throughout the Project. Maceration of sewage and kitchen waste will be conducted in accordance with the OWTG and MARPOL.

f) If removal of the wellhead is required as part of well abandonment procedures, it will be completed via mechanical separation (i.e., cutting, as opposed to the use of explosives).

g) MODU and supply vessel contractors will maintain their equipment per their management system, to ensure all equipment is properly maintained / operating efficiently, thus reducing risk of excess noise.

h) As required in the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines*, mitigation measures applied during the Project's VSP surveys will conform with those in the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environmen*t (SOCP) (DFO 2007). These include the following:

- Seismic sound levels will be kept at the minimum level required during VSP survey activities.

- At the commencement of the VSP survey activity, a gradual "ramp-up" procedure of the seismic source array over a minimum time period will be implemented in order to allow any mobile marine animals to move away from the area if they are disturbed by it.

- Trained MMOs will monitor and report on marine mammal and sea turtle sightings during any VSP surveys.

- This will enable sound source array shutdown or delay actions to be implemented if marine mammal or sea turtle species listed on Schedule 1 of SARA are detected within the monitored exclusion zone.

In addition, measures to mitigate potential environmental effects on marine fish species outlined in Section 8.3.2 will reduce the potential for effects on prey availability for marine mammals and sea turtles.

10.3.3 Presence and Operation of MODUs

The key potential environmental interactions associated with the presence and operation of the MODU(s) (including standby vessels) include possible change in habitat quality or use, and in mortality or injury levels associated with increases in underwater noise and vibrations.

10.3.3.1 Overview of Potential Effects and Existing Knowledge

Anthropogenic noise in the marine environment has been shown to have a variety of effects on marine mammals and sea turtles, particularly in the case of relatively intense sounds at close ranges. These may be physical (injury or mortality) and/or behavioural (avoidance or other changes in distribution or activities) in nature. Operation of an offshore MODU typically generates sound levels that range from approximately 130 to 190 dB re 1 µPa at 1 m, with a peak frequency range of 10 Hz to 10,000 Hz (Richardson et al 1995; Hildebrand 2005; OSPAR 2009).

If certain thresholds are met or exceeded, the underwater noise produced by the operation of a MODU or from operational activities could potentially result in mortality or injury to marine mammals and sea turtles in close proximity to the sound source. Such exposure can also result in changes in hearing ability, known as temporary or permanent threshold shift (TTS or PTS) (Richardson et al 1995; Nowacek et al 2007; Southall et al 2007). The degree and duration of these physical effects is influenced by a range of factors including the particular species involved, as well as the magnitude, frequency range, and duration of the noise source (Richardson et al 1995; Davis et al 1998, Kastelein et al 2016). Several previous studies have investigated this phenomenon (eFinneran et al 2000, 2002, 2010a and 2010b; Southall et al 2007; Gedamke et al 2011), although the noise levels that cause PTS or TTS for most marine biota are not known, including the sound levels required to cause injury as well as the specific distances within which these may be produced for particular noise levels and other conditions.

In addition to possible mortality or injury outcomes, behavioural effects may also occur when animals are disturbed or otherwise affected by underwater noise. Some of the behavioural effects that underwater noise sources have been observed to have on marine mammals include changes in vocalizations (Miller et al 2000, 2009; Parks et al 2007; Holt et al 2009; DiIorio and Clark 2010; Risch et al 2012); changes in respiration, swim speed, diving, and foraging behaviour (Stone and Tasker 2006; Nowacek et al 2007; Southall et al 2007); displacement and avoidance of habitats (Weir 2008; Castellote et al 2012; Sundermeyer et al 2012; Tougaard et al 2012; Finneran 2015); shifts in migration paths (van Opzeeland and Slabbekoorn 2012); increased stress and immune depression (Romano et al 2004; Wright et al 2007a, 2007b, 2009, 2011); and strandings (Gentry 2000; Malakoff 2002; Weilgart 2007). Generalizations on the effects of anthropogenic noise on animal behaviour are difficult to identify (Wood et al 2012, Finneran 2015). The zones of influence for marine noise appear to be larger for low frequency cetaceans (i.e. baleen whales) compared to high frequency cetaceans (Laws 2012), because higher-frequency sound waves attenuate at shorter distances.

Marine mammals also use and produce sounds both passively and actively to communicate, navigate, locate prey and predators, and to gather information about their surroundings (Richardson et al 1995; Nowacek et al 2007; Tyack 2008; LGL 2013; Shannon et al 2015). These sounds may be “masked” or interfered with by anthropogenic sources, particularly when these frequency ranges overlap (Richardson et al 1995). Several studies have documented this occurrence and have observed that species utilizing low-frequency ranges (such as baleen whales) are particularly sensitive to such disturbances (Clark et al 2009; Blackwell et al 2013; Erbe et al 2015). Other, indirect effects may occur when underwater noise results in changes in the location or abundance of food sources.

Sea turtles have also been shown to exhibit short-term physical, physiological and behavioural effects as a result of noise-related disturbances (McCauley et al 2000). Sea turtles appear to be most sensitive to low-frequency sounds, such as those produced by an operating MODU (Ketten and Bartol 2005). However, the effects of non-impulsive sound sources on sea turtles are little studied. A strong initial avoidance response to impulse noise, including seismic air-gun operations, has been reported in some studies (O'Hara and Wilcox 1990; Moein et al 1994; McCauley et al 2000; Bartol 2008). The potential effects of an operating MODU on sea turtles are therefore expected to be somewhat similar to those identified for marine mammals.

Although there are currently no formal federal guidelines or regulatory thresholds for protection of marine mammals and sea turtles from the effects of underwater sound, there are recent and generally accepted thresholds presented in the literature that can be used to inform an assessment of potential

effects on the VC due to Project-related noise. The United States NOAA National Marine Fisheries Service (NMFS) guidelines (NFMS 2016) are the most commonly applied source of guidance.

Impulse noise is defined as a sound with sudden onset and typically a short duration, such as seismic noise. This differs from non-impulse noise (continuous sound sources, such as from drilling and shipping activities) in its physiological and behavioural effects on wildlife (Larkin 1996). NMFS (2016) provides threshold levels for both peak sound pressure levels (SPL_{peak}) and 24-hour cumulative sound exposure levels (SEL_{cum}). The onset of injury, defined as PTS, is assumed when sound exposure exceeds either criterion. Guidelines are provided for both impulse and non-impulse noise sources. Thresholds vary for high-frequency cetaceans (such as porpoises), mid-frequency cetaceans (including toothed whales and dolphins) and low-frequency cetaceans (baleen whales) as well as for pinnipeds; note that although guidelines are provided for both of the major pinniped groups (otariid or eared seals, and phocid or earless seals), only earless seals are present in North Atlantic waters. Table 10.3 presents PTS threshold values summarized from NMFS (2016).

Previous guidance from the NOAA also provides sound pressure level thresholds for broadband underwater noise levels that may cause behavioural disruption of marine mammals (NOAA n.d.). These thresholds are applied to all marine mammals (cetaceans and pinnipeds). Although these behavioural thresholds were not incorporated into NFMS (2016), they are still commonly used for EAs of offshore exploration programs and are thus provided here.

Table 10.3 Acoustic Threshold Levels for Marine Mammals

Guideline / Threshold Type	Source	Effect	Hearing Group				
			Cetaceans			Pinnipeds	
			Low-frequency	Mid-frequency	High-frequency	Otariid	Phocid
Impulsive Sound (dB SPL_{peak})[1]	NMFS (2016)	PTS	219	230	202	232	218
	NOAA (n.d.)	Behavioural	160				
Impulsive Sound (dB SEL_{cum})[2]	NMFS (2016)	PTS	183	185	155	203	185
Non-Impulsive Sound (dB SPL_{peak})[1]	NMFS (2016)	PTS	No threshold defined				
	NOAA (n.d.)	Behavioural	120				
Non-Impulsive Sound (dB SEL_{cum})[2]	NMFS (2016)	PTS	199	198	173	219	201

Notes: (1) dB (decibel) SPL_{peak} has a reference value of 1 µPa.
(2) dB SEL_{cum} has a reference value of 1 µPa2-s

10.3.3.2 Residual Environmental Effects Assessment

Up to 10 wells will be drilled in ELs 1144 and 1150 over the course of the Project using semi-submersible or drillship MODUs. An MODU will take up to 160 days to drill and evaluate any particular well at a specific location, and so any associated noise disturbances will be temporary in nature.

Injury or mortality to marine mammals or sea turtles is not anticipated to occur as a result of underwater noise introduced by the presence and operation of MODUs. Results from the sound propagation modelling study (Appendix E) show that distances to PTS vary between marine mammal hearing groups. For high-frequency cetaceans, individuals remaining at 1.9 km (deepest modelled site) or 3.3 km (shallowest modelled site) from the MODU for a period of 24 hours may be subjected to PTS. This distance is shorter (≤ 230 m at both sites) for individuals from other marine mammal hearing groups. PTS may occur after a shorter period for individuals remaining within these distances, while PTS is unlikely to occur for individuals swimming in and out of the area. Based on the sound levels expected to be generated by the MODU for this Project and the sound level thresholds identified in the literature (see above), it is considered unlikely that marine mammals will be exposed to, or approach or remain within the distances required to be exposed to, any sound levels capable of causing PTS. Although there has been far less research into sea turtle hearing and the potential effects of underwater noise on these species, sea turtles are likewise not expected to approach or remain in close proximity to intense sources of underwater noise. Therefore, the potential for exposure to sound levels capable of causing PTS or mortality is considered very low. Given the overall abundance of these species and the large spatial and seasonal fluctuations in same within the LSA, the potential for interaction with the operating MODU and its noise emissions will therefore be low, and in any event, will be temporary in nature.

It is, however, possible that some temporary changes in habitat use, including displacement, will occur within tens of kilometres of the operating MODU in response to these increased levels of underwater noise. These responses will be variable in nature, and they will depend on various factors including species, location, season, and characteristics of the sound source (NRC 2005; OSPAR 2009). Some degree of behavioral effect may occur, however, in response to underwater noise such as interference in communication, alterations in activity or localized avoidance responses at the time of activity. Results from the sound propagation modelling study (Appendix E) show that marine mammal behavioural effects could occur for individuals up to 56.8 km from the MODU. However, the area affected will be small relative to overall available habitat in the RSA, and the effects are anticipated to be of short to medium-term duration. No critical habitat areas or concentrations of marine mammals or turtles are known to occur in the LSA or RSA. It is therefore very unlikely that any individuals will be displaced over extended areas or timeframes. Given that the likely zone of influence of the Project at any one time or location will represent a very small proportion of the available feeding, breeding or migration area of any species, marine mammals and sea turtles will not be displaced from any key habitats or during important activities, or be otherwise affected in a manner that would cause negative and detectable effects to overall populations in the region.

Other expected and potential environmental emissions and discharges associated with the Project will include drilling wastes (fluids and cuttings, see next section) and cement, other liquid wastes (bilge and deck drainage, ballast water, sewage, cooling water and fire control water), atmospheric emissions (exhausts from equipment), and solid wastes including food and other non-hazardous waste. These emissions are described in some detail in the Project Description (Section 2.9). All waste liquids will be treated as required and discharged in accordance with the OWTG and MARPOL, thereby reducing any

potential effects on any aspect of the marine environment. Grey wastewater from the galley, washing and laundry facilities and black wastewater from accommodations will be macerated prior to discharge. No adverse effects are anticipated as volumes would be quite small and will be highly dispersed in this relatively deep-water and dynamic marine environment (Section 5.5), resulting in overall low potential for interactions with or effects on marine biota and their habitats. Each of the MODUs and support vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a Waste Management Plan in place that will be strictly adhered to throughout the life of the Project. Hydrocarbon or other contaminant levels are strictly regulated by MARPOL and OWTG and any wastewater discharges from the MODU will be treated prior to release. Bilge and deck drainage water that comes into contact with MODU equipment may become contaminated with oil. The bilge and drainage water will be separated from oil before discharge to meet the limits prescribed by the OWTG with the oil component transported to and disposed of appropriately on shore.

Any effects resulting from the presence and operation of the MODU on the health, abundance, and distribution of marine fish species can also have indirect effects on marine mammals and sea turtles in terms of changes in food quantity and quality. Reduced food availability would result in greater energy expenditure requirements for the location and capture of prey items. The results of the assessment presented in Section 8.3.3 suggest that potential effects from presence and operation of the MODU on marine fish and fish habitat will not be significant, and as such, secondary effects from reduced food availability and quality for marine mammals and sea turtles are not expected, particularly to the degree that would translate into effects on the overall abundance, distribution or health of these species.

In summary, the potential environmental effects of presence and operation of the MODU on marine mammals and sea turtles are predicted to be adverse but low to medium in magnitude, occurring within the LSA, of short to medium-term duration and regular in frequency, and these will be entirely reversible once the disturbance is removed. This prediction is being made with a moderate level of certainty.

10.3.4 Drilling and Associated Marine Discharges

The primary potential environmental interactions associated with this component of the Project relate to a possible change in health or habitat quality due to contamination (including plume dispersion) from routine discharges of drilling fluids and cuttings into the marine environment. Any adverse effects of marine discharges on the health of marine fish (Section 8.3.4) may also have potential indirect effects on the quality and availability of food for marine mammals and sea turtles.

10.3.4.1 Overview of Potential Effects and Existing Knowledge

The chemical composition of fluids and allowable discharge types and volumes associated with drilling fluids and cuttings are regulated in compliance with the OWTG (Morandin and O'Hara 2016). However, even with adherence to regulated limits, marine discharges can result in a localized deterioration in water and sediment quality; although changes to water quality are temporary, deterioration of sediment quality will be longer term. Research suggests that drilling fluids and cuttings are, however, not likely to introduce heavy metals in concentrations that would cause health effects to marine mammals (Hinwood et al 1994).

10.3.4.2 Residual Environmental Effects Assessment

In addition to noise, discussed in the previous section, environmental considerations associated with Project-related drilling activity itself include those related to the discharge of WBMs and WBM-associated cuttings during the initial drilling phases (riserless sections), as well as the eventual discharge of SBM-associated cuttings from the MODU following their treatment and marine disposal in accordance with the OWTG.

Drilling fluids and all other chemicals will be selected and used in accordance with applicable guidelines and Nexen procedures. Although the marine disposal and deposition of drill cuttings (and any residual fluids) will cause a degree of accumulation on the seabed and associated effects on benthic communities and habitats (see Section 8.3.4), none of the marine mammals and sea turtles occurring in the LSA and RSA are known to feed on benthos (Amec 2014). Although some primary prey species (such as small fish, plankton, and other pelagic invertebrates such as squid) may be exposed to Project-related marine discharges, any associated effects on these species are expected to be localized and temporary, and detectable adverse environmental effects on this VC are therefore not anticipated.

The potential environmental effects of marine discharges associated with drilling activities, including cuttings and fluids, are predicted to be negligible in magnitude (if any such effects do occur), localized, of short-term duration and sporadic in frequency, and these will be entirely reversible once the disturbance is removed. This prediction is being made with a high level of certainty.

10.3.5 Vertical Seismic Profiling

VSP surveys employ a string of receivers placed down a well, with a sound source (usually mid-sized sound source arrays) suspended from the MODU or towed from a vessel and activated at pre-determined distances (in a “walk-away” VSP survey), and have a duration of one to two days per well. The main environmental interactions and changes resulting from these planned Project components and activities are associated with underwater noise.

10.3.5.1 Overview of Potential Effects and Existing Knowledge

Although VSPs are short-term in nature and use smaller seismic source array than that used for exploration seismic surveys, there is some potential for underwater noise produced during VSP surveys to result in injury to or behavioural changes in marine mammals and sea turtles.

PTS threshold values for impulse noise proposed for marine mammals by NMFS (2016) were provided earlier in Table 10.3. No occurrences of mortality from exposure to sounds from seismic exploration have been documented in marine mammals and sea turtles, and these animals are not expected to remain in close proximity to sound sources capable of causing injury. Indeed, some cetaceans have shown avoidance responses to operating air guns, limiting their potential for injury. For example, harbour porpoises, considered to be one of the more sensitive species to such injury, have demonstrated short-term avoidance responses and decreases in densities up to 10 km from 2D seismic surveys (peak-to-peak source SPLs of 242 to 253 dB re 1 µPa at 1 m), with most individuals returning to the seismic activity area within a few hours (Thompson et al 2013). Studies related to potential non-permanent hearing impairment, or TTS resulting from offshore seismic surveys have cited distances ranging from less than 100 m from the sound source (Ridgway et al 1997), to one kilometer or more

(Madsen et al 2006; Gedamke et al 2011). The degree and duration of TTS is influenced by a range of factors including the species involved, as well as the magnitude, frequency range, and duration of the noise source (Richardson et al 1995; Davis et al 1998, Kastelein et al 2016).

Exposure to underwater noise at or above threshold levels can result in behavioural disturbance including avoidance (Richardson et al 1995; Nowacek et al 2007), communication masking (Dyndo et al 2015; Veirs et al 2016), and changes in respiration and dive patterns (Nowacek et al 2007; Southall et al 2007). Noise from seismic sound sources can also cause masking of natural sounds and other forms of behavioural disturbance (Stone and Tasker 2006; Moulton and Holst 2010). The behavioural responses of marine mammals to seismic noise have been shown to be highly variable between species and across a range of environmental conditions (Weilgart 2007; Miller et al 2009). For example, some cetaceans have been known to utilize active seismic survey areas for foraging (e.g. bottlenose dolphins; Barry et al 2012), whereas others have been shown to avoid operating seismic source arrays. Some recent studies have indicated avoidance or other reactions up to several hundred kilometres away from seismic sound source arrays, and well after the survey is completed (Nieukirk et al 2004, 2012; Risch et al 2012; Castellote et al 2012). Wood et al (2012) for example, describe relatively high levels of behavioural reactions to seismic noise at relatively low intensity (e.g., 120−140 dB_{rms} re 1 µPa), although some species (such as minke whales) have been observed in close proximity (less than 100 m) to operating seismic source arrays (Boertmann and Mosbech 2011).

Baleen whales have been shown to respond to intense sound pulses from sound source arrays with avoidance behaviour. In extreme cases, this can result in deviation from normal migration routes and/or disruption of feeding (Malme et al 1984, 1985, 1988; Richardson et al 1986, 1995; Ljungbald et al 1988; McCauley et al 1998, 2000a, 2000b; Miller et al 1999, 2005; Gordon et al 2004; Stone and Tasker 2006; Johnson et al 2007; Nowacek et al 2007; Weir 2008; Moulton and Holst 2010). Studies have shown that repeated SPL pulses of approximately 160-170 dB_{rms} re 1 µPa resulted in avoidance behaviour in large numbers of migrating baleen whales, including grey, bowhead, and humpback whales (Richardson et al 1995). Sound levels between 120 and 130 dB_{rms} re 1 µPa caused behavioural changes in migrating bowhead whales (Miller et al 1999; Manly et al 2007). Conversely, some studies have shown limited avoidance and changes in behaviour in response to sound source arrays (LGL 2014). For example, migration of grey whales along the west coast of Canada continued despite seismic exploration and shipping activities in the area (Malme et al 1984; Richardson et al 1995). Brief exposure to sound pulses from a VSP are therefore considered unlikely to result in prolonged behavioural disturbance of mysticetes (LGL 2014).

Toothed whales also show variable response to seismic sound, although some studies have suggested that they may demonstrate some level of avoidance (Stone and Tasker 2006; Weir 2008; Richardson et al 2009; Moulton and Holst 2010). Northern bottlenose whales in the Gully Marine Protected Area showed no displacement due to received sound levels of 145 dB_{rms} re 1 µPa generated by a seismic survey taking place more than 20 km away (Lee et al 2005). Beaked whales generally avoid approaching vessels, sometimes diving for extended periods (Kasuya 1986; Würsig et al 1998), and it is expected that beaked whales would demonstrate avoidance behaviours in response to seismic activity. Harbour porpoises have shown behavioural (avoidance) responses to seismic sound source arrays at levels <145 dB_{rms} re 1 µPa (Bain and Williams 2006).

In some more recent studies, Pirotta et al (2014) used passive acoustic loggers to monitor vocalizations in harbour porpoises in an area where there had been no evidence of broad scale displacement of

animals from seismic activity. The authors determined that such vocalizations declined by 15 percent in the seismic area and that the further animals were away from activity, the greater the likelihood of vocalizations. This paper also documents evidence of sub-lethal effects of seismic sound source arrays on harbour porpoises and suggests that exposure to seismic activity could influence energy budgets through reduced foraging performance. Cerchio et al (2014) found that the number of singing humpback whales was reduced considerably during times of seismic noise, suggesting that seismic surveys have potential to disrupt breeding behaviours of these animals. Robertson (2014) determined that response of bowhead whales to seismic activity depended on the whale's activity at the time, and found that individuals spent less time at the surface when exposed to seismic activity. When accounting for these behavioural changes, it was suggested that seismic activity did not displace bowheads to the degree previously thought, but instead primarily altered their dive behaviour. Of particular concern is the potential for marine mammal disturbance associated with seismic surveys to interfere with species at risk and other rare species and small populations (Section 10.4), particularly any associated disruption of animal movements, communication or other activities during key periods such as reproduction (Croll et al 2002; Beauchamp et al 2009).

There are relatively limited available data on the effects of seismic noise on behaviour in pinnipeds. While some monitoring has reported no avoidance behaviour within hundreds of metres of the sound source array (Harris et al 2001; Moulton and Lawson 2002; Miller et al 2005), other programs reported that avoidance behaviour was observed (LGL 2014). When observed, behavioural responses of pinnipeds to seismic surveys and other anthropogenic noise in the marine environment tends to be localized in extent and short-term in duration (Richardson et al 1995). Southall et al (2007) found behavioural responses in pinnipeds in response to impulsive sound at 212 db peak SPL.

The sound frequencies produced by VSP activities overlap with the hearing range of both the loggerhead sea turtle (Martin et al 2012) and leatherback turtle (Dow Piniak et al 2012). The effects of underwater noise from seismic surveys on sea turtles are poorly understood, but because they do not use acoustic sound for foraging or communication, it is thought that threshold levels for onset of auditory injury are unlikely to be lower than those identified for cetaceans (LGL 2014). Popper et al (2014) proposed threshold levels for potential sea turtle mortality from seismic sound source arrays of 210 dB SEL_{cum} and 207 dB peak SPL; the relative risk for sea turtles exposed to seismic arrays has been described as "high" within tens of metres of the sound source and "low" within hundreds of metres, although no threshold values were proposed.

Seismic surveys have been shown to have non-lethal effects on sea turtles, including changes in hearing sensitivity, and behavioural effects such as increased and erratic swimming and avoidance responses, potentially leading to displacement from preferred foraging areas (McCauley et al 2000a; Atlantic Leatherback Turtle Recovery Team 2006). DeRuiter and Doukara (2012) reported avoidance behaviour by loggerhead sea turtles at distances of over 800 m from seismic sounds of approximately 175-191 dB re 1 µPa peak SPL; the dive probability was greater the closer the turtles were to the seismic source array. In studies of penned animals, sea turtles demonstrated increased surfacing behaviour and changes in swim patterns when exposed to received SPLs of 166 dB_{rms} re 1 µPa (McCauley et al 2000a). In a study of penned loggerhead sea turtles exposed to sound source arrays (source level: 175 to 179 dB re 1 µPa at 1 m), avoidance behaviour was observed upon first exposure (Moein et al 1994). A decrease in the abundance of sea turtles of several species in the area of active seismic surveys has been reported, although it is unclear whether this was a result of the seismic sound or the presence of the seismic vessel (Weir 2007).

10.3.5.2 Residual Environmental Effects Assessment

VSP surveys using seismic sound arrays or other equipment will be conducted as part of the Project as required. However, these will be quite short-term (one to two days per well, with the seismic source activated intermittently within that period) and localized (at the wellsite) in nature. VSP source array volumes employed in this Project will likely range from 450-2400 cubic inches (in^3) in volume with operating pressures of 2,000 pounds per square inch (psi), and will produce peak to peak pressures of approximately 20-60 bar-m in the vertical direction (directly under the VSP).

The largest of these arrays (2,400 in^3) was used in the sound propagation study (Appendix E) to produce conservative estimates of distances to marine mammal injury (PTS) and behavioural effect thresholds. Results show that low-frequency cetaceans remaining at 5.0 km (deepest site) and 9.7 km (shallowest site) from the VSP for a period of 24 hours may be subject to PTS. Distances to PTS for all other marine mammals are ≤ 380 m from the VSP. PTS may occur after a shorter period for individuals remaining within these distances, while PTS is unlikely to occur for individuals swimming in and out of the area.

The same study (Appendix E) estimated that marine mammal behavioural responses may occur within 7.7 km of the VSP. Within this distance, behavioural effects could be observed at any time during the operation of the VSP. In contrast, PTS may occur after a prescribed period of exposure. Therefore, in some instances, such as for the operation of a VSP, it is reasonable for the distance to behavioural threshold to be shorter than that for injury threshold.

Although there is some uncertainty and variability with regard to specific noise thresholds for different species of marine mammals and sea turtles, the potential for individuals to be exposed to intense underwater sound from the Project will be low, and any potential interactions will be localized and short-term in nature. Further, because marine mammals and sea turtles are mobile and often exhibit behavioural changes (avoidance) in response to such noise disturbances, it is unlikely that any individuals will approach or remain in proximity to the VSP surveys, and especially, to approach within the distances required to be exposed to sound levels capable of causing injury. The application of planned mitigation measures, such as a ramp-up procedures and the use of MMOs (see Section 10.3.2) will help to further reduce the potential for any adverse effects upon these species.

As summarized in the preceding section, behavioural reactions to exposure to seismic noise have been widely documented in marine organisms, including marine mammals and sea turtles. The available research indicates that species vary considerably in their sensitivity and reactions to seismic noise, with other factors such as time of year also appearing to influence these responses. Also, previous research and reported observations have not yielded conclusive or consistent results. This makes it somewhat difficult to state specifically and definitively whether, how, to what degree and for how long individuals or species will react to underwater noise levels such as those that will be generated through this Project and its VSP activities. It is, however, possible that any individuals that may come into close contact with underwater sound from a VSP survey program will exhibit a behavioural response to same, including displacement for a period of time from the affected area.

The predicted zone of influence of seismic sound in the marine environment (especially for marine biota as receptors) is typically defined by the area within which specific received sound levels are exceeded (LGL 2013). These thresholds can be established in terms of a maximum level of underwater sound to which cetaceans and reptiles should be exposed, which has been stated in some sources at between

160 to 190 dB re 1 µPa (see LGL 2013), or as a minimum distance of separation, such as DFO (2007) which recommends a circle with a radius of at least 500 m as measured from the centre of the seismic sound source array(s).

While the noise generated by these VSP surveys are expected to be the most intense sound emissions associated with the Project, the source levels used are lower than those required for most offshore geophysical exploration programs. Moreover, the localized (wellsite) and short-term nature of underwater disturbance at any one location and time during the VSP program considerably reduces the potential for adverse effects upon marine mammals and sea turtles to occur. It is therefore very unlikely that any individuals will be displaced over extended areas or timeframes. Given that the likely zone of influence of the Project at any one time or location will represent a very small proportion of the feeding, breeding or migration area of any species, marine mammals and sea turtles are not predicted to be displaced from any key habitats or during important activities, or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region.

Underwater noise from VSP surveys could also adversely affect marine mammals and sea turtles indirectly, through potential changes in the presence, abundance or concentration of prey and potential displacement from key foraging areas. As described in Section 8.3.5, however, extensive and persistent changes to fish resources or other marine biota are not expected to occur as a result of the Project. Therefore, the availability, location or quality of food sources for marine mammals or sea turtles are not likely to be negatively affected as a result of this Project, and especially, not to a degree or for a duration that would translate into negative and detectable effects upon this VC.

In summary, the potential environmental effects of VSP survey activities are primarily related to noise exposure. Any such effects are predicted to be adverse but low in magnitude, occurring within the LSA, short-term and sporadic in frequency, and reversible, with a high level of certainty.

10.3.6 Well Testing

The potential environmental interactions between Project-related well testing and this VC are related primarily to possible marine discharges, if and as required. The amounts of produced water associated with exploration drilling are very low, much lower than those from oil production platforms, and any quantities that are in excess of the flare capacity will be treated in accordance with the OWTG and disposed of at the MODU site. The low volumes of produced water involved, coupled with its planned treatment prior to disposal and likely rapid dilution in this dynamic marine environment means that potential adverse effects on this VC (either direct or indirect) are unlikely to occur. During well flow testing, small quantities of produced water may be periodically flared, resulting in short term and reversible air emissions localized to the immediate Project Area, and with little potential to interact with marine mammals and sea turtles or their habitats.

The predicted environmental effects of well testing are therefore predicted to be adverse but negligible to low in magnitude, localized to within the Project Area, short-term, sporadic in frequency and reversible, with a high level of certainty.

10.3.7 Well Abandonment or Suspension

Eventual well abandonment or suspension and, potentially, the associated removal of the well using mechanical means (if required) will result in short term, low magnitude emissions of noise and light. Similar to drilling operations An overview of existing knowledge regarding the effects of underwater noise and other such disturbances on marine mammals and sea turtles was provided earlier in Section 10.3.5.1. If removal of the equipment extending above the mudline is required, the casing will be cut just below the mudline and upper sections of casing and the wellhead will be lifted to surface. This may be done immediately after the well is drilled and evaluated using the MODU, or sometime after the well is suspended using a support vessel. Alternatively, approval may be sought to leave the wellhead in place on the seabed; in this case, the wellhead position will be reported with Canadian Hydrographic Services so nautical charts can be updated.

Underwater noise associated with the use of a mechanical cutter will be similar to that caused by drilling, and is not expected to produce underwater sound levels of an intensity or extent that could present a risk of mortality or injury to marine mammals or sea turtles. Individuals that are sensitive to lighting and noise emissions may temporarily avoid the area during these activities. However, these activities will be infrequent, localized and of short term duration, and the use of mechanical procedures as opposed to explosives will greatly reduce the potential for adverse effects on these species as a result of these activities.

The potential environmental effects of well abandonment or suspension are therefore predicted to be adverse, negligible to low in magnitude, localized, short-term in duration, sporadic in frequency, and reversible, with a high level of certainty.

10.3.8 Supply and Servicing

The implementation and conduct of the proposed offshore exploration program will involve support vessel and aircraft traffic to, from, and within the Project Area at all times of year throughout the Project life. This traffic may affect marine mammals and sea turtles through transient noise and other associated environmental emissions and discharges, and creates the potential for vessel strikes.

10.3.8.1 Overview of Potential Effects and Existing Knowledge

Vessel traffic and associated noise can be a source of chronic stress for marine mammal populations (Rolland et al 2012). Cetaceans and some seal species have been observed to adjust their movement behaviour around ships (Richardson et al 1995; Lalas and McConnell 2015), and to modify their vocal patterns (Clark et al 2009). Some cetacean species are also susceptible to injury or mortality from direct collisions with vessels (Williams and O'Hara 2010). Baleen whales are more susceptible to mortality from vessel strikes than other marine mammal groups (Laist et al 2001; Jensen and Silber 2003). According to Vanderlaan and Taggart (2007), North Atlantic right whales, fin whales, humpback whales and grey whales have the highest risk of mortalities. Vessel strikes have been implicated in a number of recent mortalities of North Atlantic right whales in the Gulf of St. Lawrence (Science 2017). Reducing vessel speed has been shown to reduce the number of marine mammal deaths and severe injuries due to vessel strikes (Vanderlaan and Taggart 2007; Vanderlaan et al 2008, 2009; van der Hoop et al 2012). Lethal strikes are infrequent at vessel speeds less than 25.9 km/h (14 knots) and rare at speeds less than 18.5 km/h (10 knots) (Laist et al 2001). Although vessel strikes can have serious consequences

for individuals involved, these events are rare, and avoidance behaviour tends to reduce the risk of collision. For example, beaked whales tend to avoid approaching vessels by diving for extended periods (Kasuya 1986; Würsig et al 1998).

Offshore helicopter traffic may also result in changes in habitat quality or use for marine mammals and sea turtles as a result of both auditory and visual sensory disturbance. Helicopter sound frequencies are mainly below 500 Hz, and transmission of these sounds into the marine environment depends primarily on altitude and sea surface conditions, with noise from helicopters being most intense just below the water surface and directly beneath the aircraft, with sounds attenuating over shorter distances underwater than in the air (Richardson et al 1995). Behavioural responses of cetaceans to aircraft noise can include diving, reduced surfacing periods, and breaching (Patenaude et al 2002; Luksenburg and Parsons 2009), and can depend on their activity at the time of exposure (Würsig et al 1998; Luksenburg and Parsons 2009). Responses of sea turtles to helicopter traffic are expected to be similar to those of marine mammals, although research indicates they are more reliant on visual cues than auditory ones (Hazel et al 2007).

10.3.8.2 Residual Environmental Effects Assessment

Overall, any interactions between Project-related supply and servicing activities and marine mammals and sea turtles are anticipated to be minor due to the localized and mobile (transitory) nature of these activities, and because it will generally be in keeping with the overall marine traffic that has occurred throughout the region for decades. Vessel traffic for supply and servicing of the MODU is estimated at two to three return transits per week for a single MODU, and for two MODUs this will increase proportionally. This represents a rather negligible contribution to the overall vessel traffic off Eastern Newfoundland. Project-related supply vessel traffic will utilize existing and established routes wherever possible, and will seek to maintain a steady course and safe vessel speed and avoid concentrations of marine mammals and sea turtles whenever possible to reduce the risk of a vessel strike. Similarly, the potential for exposure of marine mammals or sea turtles to disturbance from helicopter overflights is likewise anticipated to be negligible and infrequent.

Underwater sound levels produced by Project-related support vessels and helicopters are not expected to exceed threshold levels associated with TTS or PTS for either marine mammals or sea turtles. While there is some potential for individuals in close range of the support vessels to be exposed to sound levels that may trigger a behavioural response, vessel-related underwater noise during transit to the Project Area will be temporary and transient at any one location, and therefore, any potential disturbance is expected to be minor and temporary. Marine mammals and sea turtles will therefore not be displaced from any key habitats or during important activities, or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region.

The organic wastes and other materials that may be generated and discharged by offshore vessels can attract marine biota, which may increase the potential for marine mammal and sea turtle interactions with offshore activities. As discussed previously, each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a waste management plan in place that will be strictly adhered to throughout the life of the Project. Other potential environmental emissions including the release of oily water and discharges such as deck drainage, bilge water and other possible sources of emissions will also be managed through strict adherence to applicable regulations and standards. All Project-related support vessels and aircraft will

follow applicable environmental and safety regulations and guidelines, and the transitory nature of these activities means that any environmental discharges are not likely to accumulate in any single area, and will not have detectable, adverse environmental effects upon marine mammals and sea turtles and their habitats or food sources.

The potential environmental effects of supply and servicing activities are therefore predicted to be adverse, low in magnitude, localized, short term in nature, regular in frequency, and reversible, with a high level of certainty.

10.4 Species at Risk: Overview of Potential Effects and Key Mitigation

In this assessment, marine mammal and sea turtle species at risk include those species that are listed as endangered, threatened or of special concern under Schedule 1 of SARA (and are therefore, formally and legally protected) and/or which are otherwise designated by COSEWIC as endangered, threatened or of special concern. There are currently no marine mammal or sea turtle species listed under the NL ESA.

The potential environmental interactions between the Project and any marine mammal and sea turtle species at risk, and the planned and proposed mitigation measures to avoid or reduce any such adverse interactions, are the same as those for the Marine Mammal and Sea Turtle VC as a whole. Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these Species at Risk is provided in the Table 10.4 below.

Table 10.4 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	*SARA* Schedule 1 Listing	COSEWIC Assessment	Summary of Presence and Potential Interactions
Blue Whale - Atlantic Population	Endangered	Endangered	• Found in coastal and pelagic waters, frequently at shelf edge where food production is high (Beauchamp et al 2009). • Critical habitat in the estuary and Gulf of St. Lawrence is currently being identified for the species (DFO 2016a). • Few opportunistic sightings within the LSA; mostly in the winter and early spring. • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low.
Fin Whale - Atlantic Population	Special Concern	Special Concern	• Found along coastal shelf edge and offshore (COSEWIC 2005), typically in areas with high prey density. • Frequent opportunistic sightings within the LSA, particularly in the summer months (May - October). • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be high.
North Atlantic Right Whale	Endangered	Endangered	• Prefers waters 100 - 200 m deep with surface temperatures between 8 and 15°C (Kenney 2001). • Distribution related to presence and abundance of prey species; in Canada, two designated critical habitat areas: the lower Bay of Fundy and Roseway Basin on the

Species	*SARA* Schedule 1 Listing	COSEWIC Assessment	Summary of Presence and Potential Interactions
			Scotian Shelf (COSEWIC 2013). Recent increase in sightings in the Gulf of St. Lawrence (Science 2017). • Few opportunistic sightings within the LSA; may be present in the summer months. • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low.
Northern Bottlenose Whale - Davis Strait population; Scotian Shelf population	Endangered (Scotian Shelf population)	Special Concern (Davis Strait population) Endangered (Scotian Shelf population)	• Deep-diving species found in depths of 800 - 1500 m. • It is unclear to which population individuals observed in the Study Area belong; however, a recent observation of between 50 and 200 individuals in the Sackville Spur area suggest there may be a previously unknown population (CBC 2016). • Davis Strait population has been observed migrate north to south, although patterns are not consistent (Reeves et al 1993), whereas Scotian Shelf population is apparently non-migratory. • Three marine canyons, all along the Scotian Shelf, have been identified as critical habitat for the Scotian Shelf population (DFO 2016b). • Regular opportunistic sightings within the LSA; may be present year-round, mainly in the spring and summer. • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low to moderate.
Sowerby's Beaked Whale	Special Concern	Special Concern	• Deep-diving species found at continental edges and slopes in depths of 550 - 1500 m or more. • Found in cold North Atlantic waters, from Massachusetts to Labrador (Taylor et al 2008; DFO 2017). • Few opportunistic sightings within the LSA. Seasonal movements unknown; may be present year-round. • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low.
Beluga whale (St. Lawrence Estuary population)	Threatened	Endangered	• Coastal / estuarine species (ACS 2006); critical habitat has been identified in the St. Lawrence Estuary and lower reaches of the Saguenay River (DFO 2012a). • Very few opportunistic sightings within the LSA. • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low.
Killer whale (Northwest Atlantic / Eastern Arctic population)	none	Special Concern	• Nearshore and pelagic environments; sightings off Newfoundland and Labrador have been more frequent over the last decade (Lawson and Stevens 2014). • Cosmopolitan distribution, concentrated in areas of high productivity (Forney and Wade 2006). • Regular opportunistic sightings within the LSA, primarily in the summer months (May - October). • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low to moderate.

Species	*SARA* Schedule 1 Listing	COSEWIC Assessment	Summary of Presence and Potential Interactions
Harbour porpoise	none	Special Concern	• Typically found in coastal shelf, bays and estuaries, but occasionally observed offshore (Hammond et al 2008; COSEWIC 2006). • Regular opportunistic sightings within the LSA, primarily in the summer months (May - September). • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low to moderate.
Walrus	none	Special Concern	• Require shallow open areas with substrate supporting a productive bivalve community, and suitable ice or land nearby upon which to haulout (COSEWIC 2008). • Extremely unlikely. Single extralimital opportunistic sighting in LSA. • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be extremely low.
Leatherback Sea Turtle (Atlantic population)	Endangered	Endangered	• Typically found in coastal shelf waters with depths of less than 200 m (COSEWIC 2012). • To date, critical habitat has not been identified. Three high-use feeding areas in Canadian waters (DFO 2012b); none within the LSA. • Few opportunistic sightings within the LSA, primarily in the summer months (May - September). • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be low.
Loggerhead Sea Turtle	Endangered	Endangered	• In Atlantic Canada, most abundant from July to October (COSEWIC 2010), and generally associated with the Gulf Stream. Very rare within the LSA. • Potential for occurrence in the LSA, and for interaction with Project activities, considered to be extremely low.

Each of these species are highly mobile, and with the implementation of Project mitigation measures, any individuals that may be present within the Project's zone of influence are likely to move out of the area if they are disturbed by the Project. The Project will not occur within or otherwise affect identified critical habitat for any of these species.

10.5 Environmental Effects Evaluation

This section summarizes the residual effects of the Project on marine mammals and sea turtles, and presents a determination of significance for the environmental effects assessment for this VC.

10.5.1 Residual Environmental Effects Summary

Of the various potential environmental issues and interactions that may be associated with Project activities, the underwater noise emissions are often considered to have the highest potential for effects on marine mammals and sea turtles. The potential effects of such underwater noise may be physical (injury or mortality) or behavioural (avoidance, other changes in distribution or activities) in nature. As described throughout this chapter, the overall nature, localized extent and short-term duration of the

various components and activities associated with this Project and the planned implementation of standard and effective mitigations (Section 10.3.2) will mean that any potential adverse effects on this VC will generally be of negligible to low magnitude, localized extent, short to medium duration, and reversible (Table 10.5).

The presence and operation of the MODU will result in the introduction of a number of disturbances into the marine environment, including underwater noise and other emissions. The noise associated with drilling or MODU positioning may result in short to medium-term avoidance by some individuals, but is not expected to reach levels that will result in injury or mortality of marine mammals and sea turtles. Given their medium-term and localized nature, these disturbances are also not expected to lead to behavioural effects that have overall (population level) adverse effects on these biota in the LSA or beyond. All associated discharges (drill fluids and cuttings, wastewater, sewage, air emissions) from the MODU will be managed in accordance with applicable regulations and guidelines.

Underwater noise resulting from the use of seismic equipment during VSP activities may likewise result in temporary displacement of some individuals, but is not predicted to result in injury or mortality of marine mammals and sea turtles. These seismic emissions are mainly directed downwards with limited horizontal range, and VSP surveys typically use sound levels that are lower than the larger seismic (geophysical) surveys that occur throughout the region. Mobile species are expected to temporarily avoid areas of VSP operations, minimizing the potential for adverse interactions leading to injury. The application of standard mitigations such as an initial “ramp up” phase to increase initial avoidance will further limit any potential effects.

The potential environmental effects of well flow testing and associated flaring are related primarily to possible produced water discharges, as required; however, these are unlikely. During well flow testing, small quantities of oil and produced water may be periodically flared, resulting in short term and reversible air emissions localized to the immediate Project Area, and with little potential to interact with marine mammals, sea turtles or their habitats. The amounts of produced water associated with exploration drilling are typically much lower than those from oil production, and any quantities that are in excess of the flare capacity will be treated in accordance with the OWTG and disposed of at the well site. The relatively low volumes of produced water expected, coupled with its planned treatment prior to disposal and likely rapid dilution in this dynamic marine environment means that potential adverse effects on marine mammals and sea turtles and their food sources are unlikely to occur.

Eventual well abandonment or suspension and the potential removal of the wellhead using mechanical means (if required) will result in short term, low magnitude emissions of noise and light. Individuals that are sensitive to lighting and noise emissions may temporarily avoid the area during these activities, with no anticipated population level effects or other adverse environmental implications occurring as a result of these activities.

Project-related supply and servicing vessels and aircraft will make regular transits from an Eastern Newfoundland port to the Project Area during each exploration campaign, resulting in a degree of associated vessel noise, lighting and other environmental discharges such as wastewater emissions. These supply and service activities will comprise relatively routine marine transits, similar to other types of existing marine traffic occurring offshore Eastern Newfoundland. This vessel traffic will utilize existing and established routes wherever possible, and will maintain a steady course and safe vessel speed to reduce the risk of a vessel strike. The potential for exposure of marine mammals or sea turtles to

disturbance from helicopter overflights is anticipated to be negligible and infrequent. All Project-related support vessels (and aircraft) will follow applicable environmental and safety regulations and guidelines, and the transitory nature of these activities means that any environmental discharges (including waste water, light and noise) are not likely to accumulate in any single area, and will not have detectable, adverse environmental effects upon marine mammals and sea turtles.

Table 10.5 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *	
Summary of Existing Conditions and Environmental Context • The waters off Eastern Newfoundland support a diverse assemblage of marine mammals and sea turtles throughout the year, including several that are considered to be at risk or of conservation concern. • While some of these species are migratory, others may be present in the Project Area, LSA and RSA year-round. • Marine mammals and reptiles are considered ecologically, economically, culturally, and recreationally important to various stakeholder groups, including government agencies, Indigenous groups and other interested parties. • EBSAs have also been identified by DFO in this area in part because of their importance to marine mammals and sea turtles. • There is no designated critical habitat for marine mammal or sea turtle species at risk in the LSA.	**Key Mitigation Measures (See Section 10.3.2)** • Minimizing and managing discharges/emissions from Project activities, and compliance with applicable regulations and guidelines. • Existing and common vessel travel routes will be used wherever practical, vessels will seek to maintain a steady course and vessel speed. • For any required VSP surveys Nexen will operate in compliance with the relevant aspects of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*. • Seismic sound levels for VSP will be kept at the minimum level possible based on the associated technical requirements for the survey. • At the commencement of the VSP survey, a gradual "ramp-up" procedure of the seismic sound array will be implemented to allow any mobile marine animals to move away from the area if they are disturbed by it. There will also be a planned shut-down of the seismic sound arrays or reduction to the smallest, single source element during any required maintenance activities. • Trained MMOs will monitor and report on marine mammal and sea turtle sightings during VSP surveys. This will enable sound source array shutdown or delay actions to be implemented if marine mammal or sea turtle species listed on Schedule 1 of the SARA are detected within the monitored exclusion zone. • If removal of the wellhead is required as part of abandonment procedures, it will be completed via mechanical separation (i.e., cutting, as opposed to the use of explosives).

Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• Change in mortality / injury levels and health • Change in habitat availability, quality and use • Change in food availability or quality	A	L-M	L-LSA	S-M	R	R	M

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
Drilling and Associated Marine Discharges (including fluids and cuttings)	• Change in mortality / injury levels and health • Change in habitat availability, quality and use • Change in food availability or quality	A	N	L	S	S	R	H
Vertical Seismic Profiling	• Change in mortality / injury levels and health • Change in habitat availability, quality and use • Change in food availability or quality	A	L	L-LSA	S	S	R	H
Well Testing	• Change in mortality / injury levels and health • Change in habitat availability, quality and use • Change in food availability or quality	A	N-L	L-PA	S	S	R	H
Well Abandonment or Suspension	• Change in habitat availability, quality and use • Change in food availability or quality	A	N-L	L	S	S	R	H
Supply and Servicing	• Change in mortality / injury levels and health • Change in habitat availability, quality and use • Change in food availability or quality	A	L	L	S	R	R	H

Evaluation of Significance

Not Significant

- The Project is not likely to result in significant effects on marine mammals and sea turtles.
- Project-related emissions, particularly underwater sound, may result in some behavioural effects on individuals, but are unlikely to cause mortality or injury or have overall effects on populations.

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

- These effects will be minimized through implementation of appropriate mitigation measures.
- The Project is likewise unlikely to result in significant effects on marine mammal and sea turtle species at risk or their habitats.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

10.5.2 Determination of Significance

The Project is not predicted to result in significant adverse environmental effects on marine mammals and sea turtles. This conclusion has been reached with a moderate to high level of certainty based on current understanding of the effects of similar projects on the VC, the availability of literature and data used to characterize existing conditions and Project effect mechanisms, and the known effectiveness of proposed mitigation measures.

The primary mechanisms of interaction that may have negative effects on this VC are related to underwater sound, increased potential for vessel strikes, and potential emissions/discharges from the MODU. With the application of proposed mitigation measures, any Project-related disturbances (and thus, any resulting effects) are anticipated to be negligible and are not anticipated to have population-level effects. Marine mammals and sea turtles species are highly mobile, and most show large migration or movement patterns across broad ranges. Therefore, presence and abundance within the Project Area (and the LSA and RSA) are variable, as, consequently, is the potential likelihood of interaction with Project activities.

The Project is also not likely to result in significant effects on marine mammal and sea turtle Species at Risk or their habitats. No critical habitats for marine mammal and sea turtle Species at Risk are currently defined in or near the Project Area and LSA.

10.6 Environmental Monitoring and Follow-Up

Nexen will develop and implement an operational monitoring program for marine mammals during VSP surveys for the Project:

- A trained MMO will be onboard to record marine mammal and sea turtle sightings during VSP survey operations.
- Visual monitoring for the presence of marine mammals and sea turtles within a pre-determined exclusion zone will take place during VSP operations where a seismic sound source array is used.
- Observational / shutdown procedures will follow the SOCP for marine mammals and sea turtles.
- A report of the observational program will be submitted annually to the C-NLOPB and DFO, including documentation of marine mammal and sea turtle sightings.
- Any vessel strikes involving marine mammals or sea turtles will be reported to DFO within 24 hours.

No specific follow-up related to the marine mammals and sea turtles VC is considered necessary in relation to the Project to confirm effects predictions or the effectiveness of the mitigation measures proposed herein.

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11 SPECIAL AREAS: ENVIRONMENTAL EFFECTS ASSESSMENT

A number of marine and coastal areas within and off Newfoundland and Labrador have been designated as protected under provincial, federal or other legislation and processes, or have otherwise been identified as being special or sensitive due to their ecological or socio-cultural characteristics and significance. Special areas have been selected as a VC for this EIS due to their importance for environmental and socioeconomic reasons, and associated regulatory and stakeholder interest in these areas.

Most of the special areas identified in Eastern Newfoundland are located on land or in coastal and nearshore areas, well outside of the Project Area. Special areas in offshore locations off Eastern Newfoundland include various Fishing Closure Areas (FCAs) that protect sensitive benthic habitats from bottom fishing activities, but with no associated prohibitions of petroleum exploration and development activities within their boundaries. Other identified special areas include Vulnerable Marine Ecosystem (VME) areas identified by the Northwest Atlantic Fisheries Organization (NAFO) for their high ecological or biological activity, portions of which may eventually be designated as FCAs. In addition, Ecologically and Biologically Significant Areas (EBSAs) are ecologically important or sensitive areas identified through the Canadian *Oceans Act*. These and other types of special areas, were identified, mapped and described in detail in Section 6.4 of this EIS.

11.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for special areas, as well as the various criteria that have been established for the evaluation of the significance of any predicted effects on this VC.

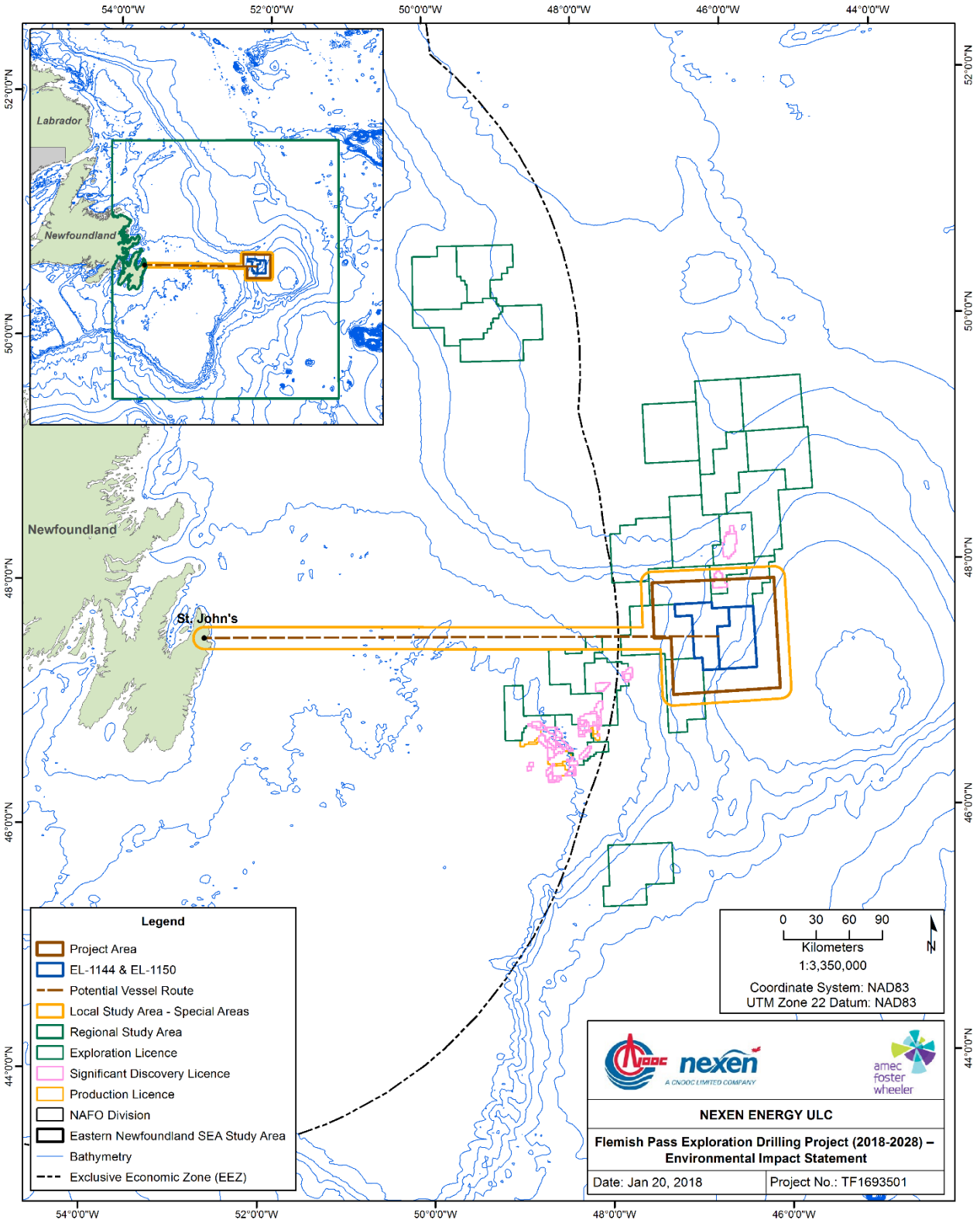
11.1.1 Spatial Boundaries

Three spatial Study Areas have been identified and considered in conducting the environmental effects assessment for this VC, as follows (Figure 11.1):

Project Area: This area encompasses the overall geographic area offshore Eastern Newfoundland within which all planned Project-related exploration activities will take place. This includes ELs 1144 and 1150, within which drilling will occur, as well as a surrounding 20 km buffer area to account for any ancillary activities (such as walk away VSP surveys) that may extend outside the boundaries of the ELs themselves. While the Project Area is defined as an overall polygon that encompasses all such activities over the course of the Project, the various activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's components and activities, and therefore, encompasses the overall geographic area over which all planned Project-related environmental interactions (including any emissions and other disturbances) are predicted to occur. As described for the preceding biological VCs, the LSA for this VC is also defined as the Project Area and the associated vessel and aircraft traffic route, and an appropriately 10 km area around these.

Figure 11.1 Special Areas: Environmental Assessment Study Areas



Regional Study Area (RSA): In addition to Project- and disturbance-related factors, the environmental effects assessment also recognizes and considers the particular characteristics and distributions of the individual VCs under consideration, including the larger regional areas and geographic and environmental contexts within which they occur and function. This includes consideration of the various ecological boundaries for marine biota which are known or likely to use the LSA and which are relevant to the identification and designation of the special areas under consideration, as well as applicable human uses. Key aspects of these environmental components and their distributions as they relate to the Project Area / LSA are as presented in Chapter 6 and are generally considered in assessing both potential Project-specific (this chapter) and cumulative (Chapter 15) effects upon this VC. The overall RSA for the environmental effects assessment is therefore as defined and illustrated earlier in Section 4.3.1.

11.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the potential duration of Project-related activities in the Project Area (2018-2028, see Section 2.7), as well as the likely timing of any resulting environmental effects. In conducting the assessment, special consideration is also given to any particularly important or sensitive periods for the environmental features and processes and associated human uses of the special areas that comprise this VC.

11.1.3 Environmental Effect Significance Definitions

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects from planned activities on this VC and their significance are assessed and evaluated.

Significant environmental effects for the special areas VC are defined as those that would cause:

- *An adverse change in one or more of the important and defining ecological and socio-cultural characteristics of such an area, resulting in a decrease in its overall integrity, value or use*

Many of the special areas discussed and assessed here have been identified and/or designated based on their biophysical characteristics and processes or human uses and values. Thus, these special areas are inherently discussed and considered (either directly or indirectly) in various other effects assessment chapters, particularly marine fish and fish habitat (Chapter 8), marine and migratory birds (Chapter 9) and marine mammals and sea turtles (Chapter 10). Any applicable special areas and their use are also considered in assessing the potential effects of the Project on cultural, tourism or recreational resources and activities in fisheries and other ocean uses (Chapter 13).

This VC chapter provides an assessment and evaluation of the potential effects of the Project's planned activities on these identified special areas as a whole, including the overall biophysical and socioeconomic features, values and uses that form key parts of the rationale for their identification and designation. It therefore considers the potential for Project-related environmental changes to affect the overall and underlying characteristics, integrity and value of these areas.

11.2 Potential Environmental Changes, Effects and Associated Parameters

Changes to the environment as a result of offshore oil and gas exploration activities and their potential, resulting effects on identified special areas may be both direct and indirect in nature and cause.

The conduct of oil and gas exploration activities directly within or near such areas may, for example, have adverse implications for these locations and their important and defining ecological and sociocultural characteristics. These interactions may occur through the possible presence of oil and gas exploration equipment, personnel and activities within the Special Area in question, as well as the associated emissions and resulting environmental disturbances that may occur in these marine environments. Biophysical effects resulting from oil and gas exploration or other human activities within the environmental assessment Study Areas may also "spread" to adjacent special areas by affecting the actual or perceived water quality and marine fish, birds, mammals or other environmental components that move to and through these areas. Any resulting decrease in the real or perceived integrity of these areas in the short or long term may also affect their ecological and/or societal importance, use and value.

The EIS Guidelines identify and specify a number of issues and potential effects on this VC, which require consideration in the EIS. These are listed in detail in the Table of Concordance included at the beginning of the EIS.

The environmental effects assessment for this VC considers and focuses upon the various issues and questions identified through these various issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from planned Project activities. These are summarized in Table 11.1, along with the identification of key associated parameters through which these Project-related changes and effects may be reflected.

Table 11.1 Potential Project-Related Environmental Changes and Resulting Effects: Special Areas

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s) (Where relevant to the underlying rationale for a particular area's identification as a Special Area)
Special areas have been identified under provincial, federal and/or other legislation and processes as a result of their ecological, biological, historical and/or socio-cultural characteristics and importance. Any direct or indirect changes to the existing natural or human environments in the area as a result of Project-related environmental emissions, disturbances or other interactions may affect the key environmental characteristics and processes (e.g.,species presence and abundance, other biophysical characteristics) that define and	*Change in Environmental Features and/or Processes* *Change in Human Use and/or Societal Value*	• Number, diversity and health of marine biota using the area • Marine habitat availability and quality within the area • Overall functioning, health and integrity of integral and defining ecological processes and features • Nature, intensity, quality and value of existing and defining human uses and activities within the special area • Type and degree of societal value placed on the special area and its defining characteristics

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s) (Where relevant to the underlying rationale for a particular area's identification as a Special Area)
distinguish these areas, and thus, affect their overall and underlying characteristics, integrity and value.		

An overview of the potential for each of the Project's planned components and activities to result in one or more of the above noted potential environmental effects on this VC is presented in Table 11.2.

Table 11.2 Potential Project-VC Interactions and Associated Effects: Special Areas

Project Component/Activity	Potential Environmental Effects *	
	Change in Environmental Features and/or Processes	Change in Human Use and/or Societal Value
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●
Drilling and Associated Marine Discharges (including fluids and cuttings)	●	●
Vertical Seismic Profiling	●	●
Well Testing	●	
Well Abandonment or Suspension	●	
Supply and Servicing	●	●
* Should Project-related activities and disturbances interact directly or indirectly with Special Areas		

11.3 Environmental Effects Assessment and Mitigation

This special areas VC focuses on marine and coastal areas in and off Eastern Newfoundland that have been identified under various legislation or processes, as discussed in Section 6.4. The effects of Project components and activities on any other areas that have been identified as being important or sensitive from a biological perspective (such as any fish spawning areas, bird colonies, etc.) have been considered and assessed within other relevant parts of this EIS (Chapters 8 to 10).

11.3.1 Approach and Methods

Completing the environmental effects assessment for this VC included identifying and mapping the various types of special areas in the LSA and RSA, describing the rationale for their identification and designation, and obtaining the most complete and up to date information on them, including their current boundaries and characteristics including any known upcoming or recent changes to the status of these areas or their defined boundaries. Geo-spatial data related to each of the types of marine and coastal Special areas were incorporated into a geodatabase in a GIS to measure and illustrate their location and extents in relation to the Project Area (marine areas and associated vessel and aircraft traffic route). The effects assessment also considered the nature and anticipated geographic extent of any environmental emissions and disturbances that may be associated with planned Project activities (as defined by the LSA for this VC).

11.3.2 Summary of Key Mitigation

For any formally protected areas, oil and gas related activities may be prohibited or otherwise restricted, pursuant to applicable legislation, to avoid or reduce the potential for negative effects on these areas. For other (identified, important but not formally protected) special areas, the various environmental mitigation initiatives identified and proposed throughout this EIS will also be applicable to these (particularly, their biophysical aspects), and their implementation would also serve to help avoid or reduce any associated effects on special areas.

11.3.3 Environmental Effects Assessment (All Planned Components and Activities)

Some of the key components and activities, and potential interactions, that may be associated with the Project and which would be particularly relevant to the environmental effects analysis for special areas, include:

- Presence and operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation);
- Drilling and associated marine discharges (including fluids and cuttings);
- Vertical seismic profiling;
- Well testing;
- Well abandonment or suspension; and
- Supply and servicing.

Based on these various components and activities, some of the key potential environmental issues and potential environmental changes that may be associated with the Project are identified below:

- The general presence of Project components (MODUs, vessels, other equipment) and activities in the offshore environment, including the noise, light and other associated disturbances.

- Possible effects on water quality and on the seabed (benthic) environment due to physical disturbance of the substrate (and associated sedimentation), the discharge and deposition of drill cuttings and fluids, and other potential environmental emissions during planned activities.

- Potential changes in the presence, abundance, diversity and health of marine biota in the area due to potential injury or mortality, or possible behavioral effects. This may include temporary avoidance of areas by marine fish, birds, mammals and sea turtles due to underwater noise or other disturbances, which may alter their presence and abundance as well as disturbing movements/migration, feeding or other activities. There may also be possible attraction of marine fish, birds, mammals and sea turtles to MODUs and vessels, with increased potential for injury, mortality, contamination or other interactions (e.g., collisions).

These or other environmental changes and biophysical effects resulting from planned Project components and activities may, in turn, have adverse effects on special areas by affecting their real or perceived overall ecological characteristics, integrity, use and value. Project activities may also result in direct interference with, and possible reduced human access to, important and valued marine areas during Project activities in certain locations, with possible decreases in these activities and their success, efficiency, value or enjoyment.

A description (and mapping) of each of the marine and coastal areas within and adjacent to the Project Area/LSA and RSA that have been designated as protected or identified as otherwise special or sensitive was provided in Section 6.4. The following sections provide an assessment and evaluation of the potential effects of planned Project activities on these special areas. Again, the previously identified mitigation measures are considered integrally within the environmental effects analysis, as relevant.

Table 11.3 below provides a summary of the (minimum) distance between the edge of the LSA, Project Area, ELs 1144 and 1150, and the identified support vessel/aircraft traffic route and the various Special areas identified and mapped in Section 6.4. As indicated, planned Project activities will occur in an offshore marine area that is over 400 km from the shoreline of Eastern Newfoundland. These planned Project activities will therefore not occur within, or otherwise interact directly with, any of the existing provincially-defined special areas (such as provincial ecological reserves, parks and protected areas or historic sites), each of which are between approximately 400 and 650 km from the closest part of the Project Area boundary. Likewise, the Project will not have a direct interaction with most federally designated areas (marine protected areas, fisheries closures within Canada's EEZ, preliminary representative marine areas, migratory bird sanctuaries, national parks and historic sites). International designations such as Important Bird Areas will also not be directly affected by the Project.

As illustrated in Table 11.3 and Figure 11.2, the Project Area does overlap with small portions of three NAFO Fishery Sponge, Coral and Seapen Closure Areas. Within these areas, Canada's *Fisheries Act* restricts particular fishing activities but petroleum exploration activities such as those being proposed for this Project are not prohibited. Only one of these NAFO Closure Areas overlaps with any part of the ELs themselves. In addition, a number of special areas (VMEs, NAFO FCAs, a Marine Refuge, and an EBSA) are located within the general vicinity of (within 50 km of) the LSA boundary.

The identified general vessel/aircraft traffic route from Eastern Newfoundland to the Project Area does, given its possible commencement at a onland port site in this region, occur within one kilometer of several coastal special areas in Eastern Newfoundland (a National Historic Site and an IBA), and within 5 km of several others (Table 11.3). It also overlaps with one EBSA offshore (Figure 11.2).

The overall and defining environmental features and characteristics of the various special areas that overlap with or occur in the vicinity of the Project Area and traffic route will not be adversely affected by the planned Project activities. The planned exploration activities are characterised by small environmental footprints and are temporary in nature. Moreover, the implementation of the various environmental mitigation measures outlined throughout this EIS, including those designed to avoid or reduce Project-related discharges and/or disturbances and their associated environmental changes and resulting effects, will also serve to help address any direct or indirect potential environmental effects that may have implications for overlapping or adjacent special areas.

The various NAFO Fishery Sponge, Coral and Seapen Closure Areas that overlap with the Project Area have been designated as such to protect important and sensitive benthic components and habitats from further disturbance due to certain types of (bottom dragging) fishing activity, but these designations do not prohibit petroleum exploration activities in these areas. As discussed in Chapter 2, the planned drilling and associated activities will be characterized by a relatively small zone of influence (footprint), with other mitigations proposed and planned to avoid or reduce potential changes to and effects on these aspects of the biophysical environment. As also referenced earlier, the Proponent will undertake a seabed investigation prior to exploration drilling, and will implement the associated mitigation to help

protect these environmental components (see Chapter 8). Many of the other offshore activities that are planned to be undertaken as part of this Project (such as VSP) will not result in any direct contact with the seabed, and will therefore not physically disturb benthic animals or their habitats.

Table 11.3 Special Areas: Summary of Minimum Distances from the LSA, Project Area, ELs 1144 and 1150 and Potential Vessel and Aircraft Route

Name	Type	Distance to LSA (km)	Distance to Project Area (km)	Distance to EL 1144 and/or EL 1150 (km)	Distance to Traffic Route (km)
Flemish Pass/Eastern Canyon (2)	NAFO Closure	Overlaps	Overlaps	14.7	35.7
Northwest Flemish Cap (10)	NAFO Closure	Overlaps	Overlaps	6.1	35.1
Northwest Flemish Cap (11)	NAFO Closure	Overlaps	Overlaps	Overlaps	1.6
Southern Flemish Pass to Eastern Canyons	VME	Overlaps	6.2	31.3	59
Northeast Shelf and Slope	EBSA	Overlaps	11.3	31.5	Overlaps
Northwest Flemish Cap (12)	NAFO Closure	15.2	25.2	51.8	88.5
Northern Flemish Cap	VME	21.9	31.9	64.1	104.8
Sackville Spur	VME	26.3	36.3	56.6	87.8
Northeast Shelf and Slope (within Canadian EEZ)	VME	13.6	36.4	56.5	22.1
Sackville Spur (6)	NAFO Closure	28.8	38.8	59.1	89.9
Northeast Newfoundland Slope Closure	Marine Refuge	35	45	73	68
Northern Flemish Cap (7)	NAFO Closure	46.2	56.2	88.5	129.4
Northern Flemish Cap (9)	NAFO Closure	47.8	57.8	88.1	126.2
Beothuk Knoll	VME	50.2	60.2	80.7	110.7
Beothuk Knoll (13)	NAFO Closure	66.5	76.5	96.8	130.9
Northern Flemish Cap (8)	NAFO Closure	69.0	79	110.5	149.7
Beothuk Knoll (3)	NAFO Closure	107.3	117.3	137.7	167.9
Deep Water Coral Area	VME	109.5	119.5	146.9	188.7

Name	Type	Distance to LSA (km)	Distance to Project Area (km)	Distance to EL 1144 and/or EL 1150 (km)	Distance to Traffic Route (km)
Northeast Flemish Cap (5)	NAFO Closure	109.6	119.6	150.1	191.4
Eastern Flemish Cap (14)	NAFO Closure	119.5	129.5	150.2	185.1
Eastern Flemish Cap (4)	NAFO Closure	126.6	136.6	161.7	202.9
Flemish Cap East	VME	161.3	171.3	192.9	228.2
Lilly Canyon-Carson Canyon	EBSA	179.5	189.5	222.3	219.7
Virgin Rocks	EBSA	75.8	222.2	247.9	86.7
Orphan Spur	EBSA	179.7	222.9	251.4	188.7
Orphan Knoll	Seamount Closure	217.0	227	247.6	276.7
Virgin Rocks	PRMA	53.8	230.4	255.7	64.4
Southeast Shoal and Tail of the Banks	EBSA	262.9	272.9	306.3	286
South Grand Bank Area	PRMA	268.4	281.2	314.8	278.4
Tail of the Bank (1)	NAFO Closure	317.0	327	358.2	356.1
South East Shoal and Adjacent Shelf Edge/Canyons	VME	291.9	329	359.6	302.7
Newfoundland Seamounts	Seamount Closure	328.6	338.6	359	389.1
Eastern Avalon Coast	EBSA	Overlaps	384.9	405.4	4.2
Northwestern Conception Bay	PRMA	29.7	402.3	423.9	39.8
Cape Spear Lighthouse	National Historic Site	Overlaps	403.2	423.4	4.9
Quidi Vidi Lake	IBA	Overlaps	405.8	425.9	0.3
Signal Hill	National Historic Site	Overlaps	407	427.2	0.4

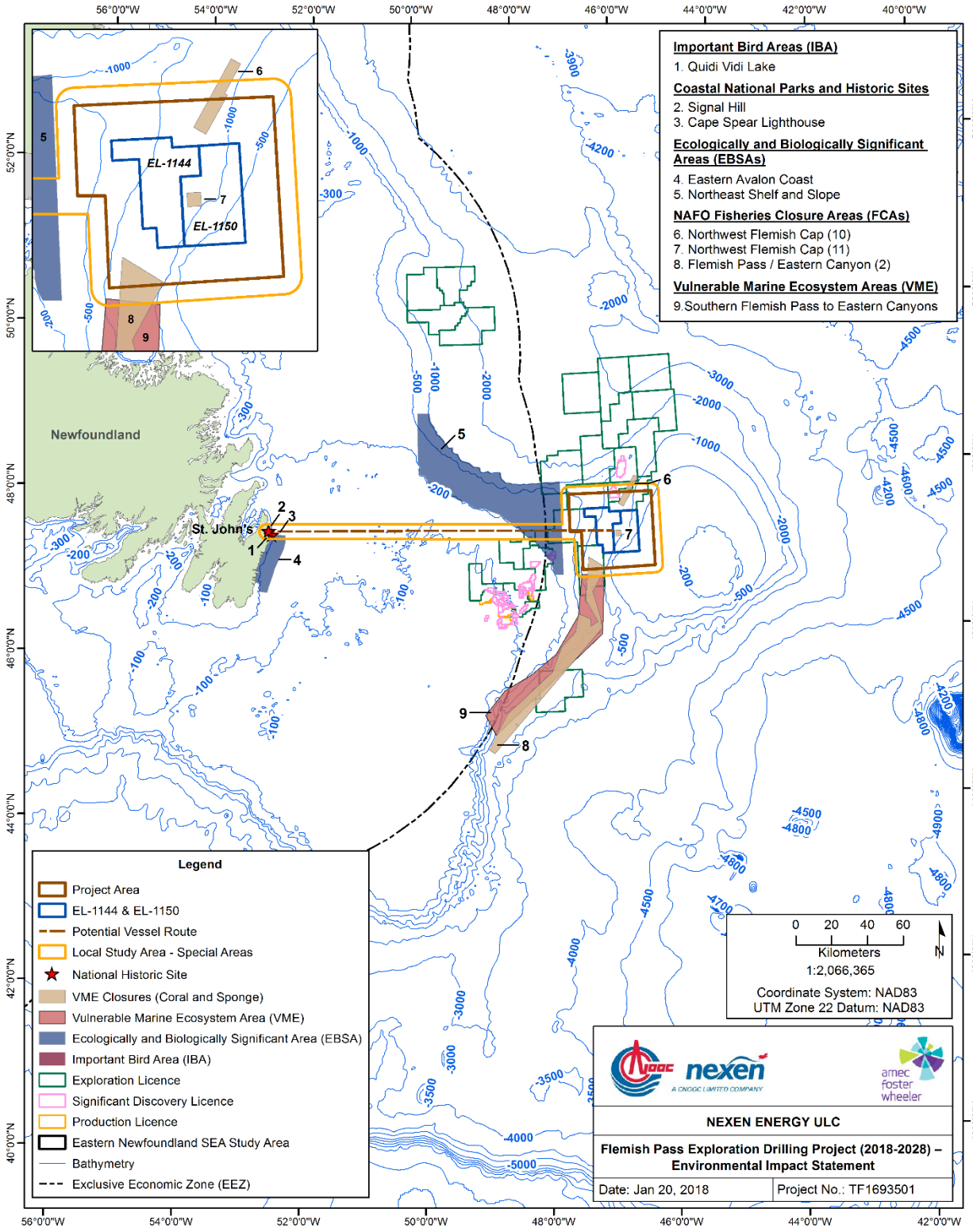
Name	Type	Distance to LSA (km)	Distance to Project Area (km)	Distance to EL 1144 and/or EL 1150 (km)	Distance to Traffic Route (km)
Cape St. Francis	IBA	13.0	408	428.2	22.9
Baccalieu Island	IBA	48.7	410.3	432.1	58.5
Baccalieu Island	Ecological Reserve	53.6	413.1	434.9	63.4
Witless Bay Islands	IBA	21.0	413.9	435.2	31.4
Marine Drive Provincial Park	Provincial Park	11.6	415.3	435.4	21.6
Grates Point	IBA	52.3	415.7	437.7	62.2
Witless Bay	Ecological Reserve	28.3	418.2	439.7	38.7
Funk Island Deep Box (also Funk Island Deep Marine Refuge)	FCA / Marine Refuge	223.5	428.2	455.5	233.2
Notre Dame Channel	EBSA	225.1	430.6	457.9	234.8
Dungeon Provincial Park	Provincial Park	115.7	438.4	462.4	125.6
Cape Bonavista Lighthouse	Provincial Historic Site	119.2	439.2	463.4	129.2
Ryan Premises	National Historic Site	114.2	440.3	464.2	124.1
Chance Cove Provincial Park	Provincial Park	80.8	444.6	467.8	91.3
Fogo Shelf	EBSA	181.2	450.7	476.8	191
Mistaken Point	IBA	95.8	452.1	475.8	106.3
Heart's Content Cable Station	Provincial Historic Site	50.4	457	477.6	61.1
Mistaken Point	UNESCO	100.5	459.1	482.7	111
Mistaken Point	Ecological Reserve	98.4	460.5	484	109
Smith Sound	EBSA	83.6	463.7	485.9	94

Name	Type	Distance to LSA (km)	Distance to Project Area (km)	Distance to EL 1144 and/or EL 1150 (km)	Distance to Traffic Route (km)
Eastport Peninsula Lobster MA	FCA	126.3	470.4	494.2	136.5
Funk Island	IBA	230.0	470.6	497.7	239.8
Cape Freels Coastline and Cabot Island	IBA	163.3	471.7	497.4	173.4
Funk Island	Ecological Reserve	236.6	477.1	504.2	246.4
Terra Nova National Park	IBA	119.1	479.6	503.3	129.4
The Cape Pine and St. Shotts Barren	IBA	109.1	483	506.4	119.8
Eastport - Duck Island	Marine Protected Area	139.5	483.6	507.7	149.7
Terra Nova National Park of Canada	National Park	125.0	483.8	507.2	132.1
Windmill Bight Provincial Park	Provincial Park	189.8	485.5	511.3	199.8
Bellevue Beach Provincial Park	Provincial Park	68.7	487.3	507.3	79.6
Eastport - Round Island	Marine Protected Area	129.9	491.5	514.9	140.2
Placentia Bay Extension	EBSA	75.0	494.1	514.5	86
Placentia Bay	IBA	81.0	496.9	517.8	92.1
Deadman's Bay Provincial Park	Provincial Park	199.7	497.3	523.1	209.8
Terra Nova	Migratory Bird Sanctuary	139.6	500.1	523.8	149.9
Castle Hill	National Historic Site	90.8	506.7	527.6	101.8
Wadham Islands and adjacent Marine Area	IBA	221.0	506.8	533.3	231.1
Gooseberry Cove Provincial Park	Provincial Park	107.6	518.3	539.8	118.6
Cape St. Mary's	IBA	120.0	520.6	543.2	130.9

Name	Type	Distance to LSA (km)	Distance to Project Area (km)	Distance to EL 1144 and/or EL 1150 (km)	Distance to Traffic Route (km)
Southwest Shelf Edge and Slope	EBSA	283.8	526.6	560.9	294.4
Cape St. Marys	Ecological Reserve	130.1	530.8	553.2	141.1
3O Coral Closure	3O Coral Closure	317.7	551.4	586.4	327.7
Grey Islands	EBSA	272.6	552.1	578.9	282.7
Division 3O Coral Closure	VME	317.7	552.8	587.5	328.4
Dildo Run Provincial Park	Provincial Park	254.6	575.3	601.1	264.9
Labrador Slope	EBSA	538.4	589.3	617	547.9
Corbin Island	IBA	188.9	602.9	624.4	199.9
Southern Coast of Burin Peninsula & Southwestern *	PRMA	195.0	608.3	630	206
Frenchman's Cove Provincial Park	Provincial Park	196.7	615.1	635.8	207.7
Lawn Bay	Ecological Reserve	221.4	635	656.6	232.4
Middle Lawn Island	IBA	221.7	635.1	656.8	232.7
Fortune Head	Ecological Reserve	233.8	651.2	672.2	244.8
Fogo Seamounts 1	Seamount Closure	549.6	663.7	698.2	559.9
Bell Island South Coast	IBA	392.8	669.4	696.9	403
Green Island	IBA	255.3	670.4	691.9	266.3
Labrador Marginal Trough	EBSA	559.5	675.1	703.4	569.3
Île aux Canes MBS	Migratory Bird Sanctuary	397.1	677.7	705.2	407.4
Northern Groais Island	IBA	411.7	681.8	709.5	421.9

Name	Type	Distance to LSA (km)	Distance to Project Area (km)	Distance to EL 1144 and/or EL 1150 (km)	Distance to Traffic Route (km)
Sheppard Island	Migratory Bird Sanctuary	402.8	682.6	710.1	413
Fischot Islands	IBA	441.6	701.1	729	451.8
St. Pierre Bank	EBSA	300.5	706.6	729.3	311.5
L'Anse aux Meadows	UNESCO	472.3	716.4	744.6	482.5
Laurentian Channel and Slope	EBSA	359.7	742.7	767.4	370.6
Fogo Seamounts 2	Seamount Closure	705.7	752.5	785	716
St. Peter Bay	IBA	539.6	755.6	784.1	549.6
Gros Morne National Park of Canada	National Park	402.0	767.2	792.4	411.1
Gilbert Bay	EBSA	571.4	776.5	805	581.5
Red Bay Basque Whaling Station	UNESCO	525.2	779.8	807.9	535.4
Point Amour, Strait of Belle Isle	IBA	513.6	788.1	816	523.9
Gilbert Bay	Marine Protected Area	597.4	805.3	833.9	607.4
Hamilton Inlet	EBSA	670.7	837.3	865.9	680.7
Laurentian Channel	Marine Protected Area	359.7	742.7	767.4	370.6
Hawke Channel -(also Hawke Channel Marine Refuge)	FCA / Marine Refuge	541.4	661.5	690	551.4
Bay du Nord Wilderness Reserve and Middle Ridge Wildlife Reserve	IBA	126.6	528.6	550.6	136.1

Figure 11.2 Overview of Special Areas that Overlap with the Project Area, LSA and Potential Traffic Route



In addition, the offshore support vessel and aircraft activity within the Project Area and to and from Eastern Newfoundland will make a relatively minor contribution to the overall offshore petroleum marine activity (especially, vessel and aircraft traffic) that has occurred throughout the region for decades and general marine traffic that has existed for hundreds of years. Supporting vessels and aircraft that are involved in Project activities will, under normal conditions, be expected to travel directly between an established port facility in Eastern Newfoundland and the MODU operating within an EL (see Section 2.5.2.6) in the Project Area. Specific travel routes may vary at times based on the particular location of the active MODU(s), the shore-based support facility being used, environmental conditions (including weather and ice) and other logistical factors. The planning and conduct of Project-related support vessel traffic will be undertaken in consideration of these factors, relevant regulatory requirements, and through established cooperative processes that involve discussions and communications between the oil and gas sector, fishing industry and other ocean uses.

As described for the various preceding biophysical VCs (Chapters 8 to 10), the planned Project activities are not expected to result in any significant adverse environmental effects on marine fish, marine and migratory birds, marine mammals, sea turtles, species at risk or their habitats. It will therefore not adversely affect the ecological features, processes and integrity of any marine or coastal locations that are designated as special areas (including any key biophysical characteristics, and species presence and abundance), nor their associated human use and value.

11.4 Environmental Effects Evaluation

This section summarizes the residual effects of the Project on special areas and presents a determination of significance for the environmental effects assessment for this VC.

In terms of the various special areas that overlap with the Project Area (offshore and associated support vessel and aircraft traffic route), the overall and defining physical, biological and socioeconomic environments within these areas will not be adversely affected by planned Project activities. Many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized and temporary at any particular location, and the implementation of the various environmental protection measures and procedures outlined throughout this EIS, especially those related to marine fish and fish habitat, marine and migratory birds and marine mammals and sea turtles will serve to further address any direct or indirect potential effects on the existing environmental characteristics and conditions of these special areas (Table 11.4).

As described and summarized above, the Project is therefore not likely to result in significant adverse residual environmental effects on special areas.

11.5 Environmental Monitoring and Follow-up

The various environmental monitoring initiatives outlined earlier in relation to relevant components of the biophysical environment will also be applicable to special areas (see Section 8.6). Nexen will also continue to track any new or revised special area designations within the RSA over the course of the Project. No additional and specific environmental monitoring or follow-up is considered necessary in relation to this VC.

Table 11.4 Environmental Effects Assessment Summary: Special Areas

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
Summary of Existing Conditions and Environmental Context • A number of special areas exist in the marine environment off Eastern Newfoundland, and also in coastal areas or in the nearshore environment and are therefore quite distant from the LSA. • No special area designations that prohibit oil and gas exploration are located within or near the LSA.						**Key Mitigation Measures** • Mitigation measures that are designed to avoid or reduce the effects of planned Project components and activities on marine biota, habitats and other marine users will also help to address any associated effects on special areas		
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• Possible change in environmental features and/or processes • Possible change in human use and/or societal value	N-A	N	L	S	R-S	R	H
Drilling and Associated Marine Discharges (including fluids and cuttings)	• Possible change in environmental features and/or processes • Possible change in human use and/or societal value	N-A	N	L	S	S	R	H
Vertical Seismic Profiling	• Possible change in environmental features and/or processes • Possible change in human use and/or societal value	N-A	N	L	S	S	R	H
Well Testing	• Possible change in environmental	N-A	N	L	S	S	R	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
	features and/or processes							
Well Abandonment or Suspension	• Possible change in environmental features and/or processes	N-A	N	L	S	S	R	H
Supply and Servicing	• Possible change in environmental features and/or processes • Possible change in human use and/or societal value	N-A	N	L	S	R	R	H

Evaluation of Significance

Not Significant

- Oil and gas exploration activities are not prohibited within any of the special areas that overlap with the Project Area, LSA or vessel / aircraft route.
- For the various special areas that overlap with or are in the vicinity of the Project Area (offshore and associated vessel and aircraft traffic route), the overall and defining physical, biological and socioeconomic environments within these areas will not be adversely affected by the Project.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

12 INDIGENOUS PEOPLES: ENVIRONMENTAL EFFECTS ASSESSMENT

This VC chapter assesses and evaluates the potential effects of the Project's planned components and activities on Indigenous peoples. The environmental effects assessment for this VC focuses on and addresses each of the associated factors specified in and required under CEAA 2012, as follows:

> *5 (1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are…*
>
> > *(c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on*
> >
> > > *(i) health and socio-economic conditions,*
> > >
> > > *(ii) physical and cultural heritage,*
> > >
> > > *(iii) the current use of lands and resources for traditional purposes, or*
> > >
> > > *(iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.*

The EIS Guidelines (Part 2, Section 5.1) identify a number of Indigenous groups in Newfoundland and Labrador, the Maritime Provinces and Quebec, and require that the EIS provide "a description and analysis of how changes to the environment caused by the project will affect the … activities as exercised [by] each group…as applicable to the proposed project:" (Section 6.3.7), including: 1) the current use of lands and resources for traditional purposes, 2) human health, 3) socio-economic conditions, 4) physical and cultural heritage, and 5) structures, sites or things of historical, archaeological, paleontological or architectural significance to groups, while also noting that other potential effects of changes to the environment on groups should be reflected as necessary.

This chapter assesses and evaluates the potential effects of planned Project components and activities on this VC. Those which may result from possible accidental events are discussed in Chapter 16.

This VC also relates to and overlaps with other components of the natural and socioeconomic environments, including several of the other VCs being considered in this assessment. Potential effects to Indigenous peoples and their communities, activities and interests may, for example, result from changes in air quality (Chapter 14) and noise levels, in the availability and quality of marine resources and other components of the biophysical environment (Chapters 8-10), and other human components and activities (Chapter 13). These potential inter-relationships are considered in a fully integrated manner within the environmental effects assessment for this VC. This includes the potential for the environmental changes associated with the Project (emissions, etc.) to extend to and interact directly with Indigenous communities and their activities. It also includes an analysis of the geographic extent and movement patterns of marine-associated species and other resources that are used by these groups and their potential to move through, and interact with, the Project's anticipated environmental zone of influence (as defined by the LSA, see below).

12.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for this VC, as well as the environmental effects evaluation criteria that are used to define and determine the significance of the Project's predicted environmental effects.

12.1.1 Spatial Boundaries

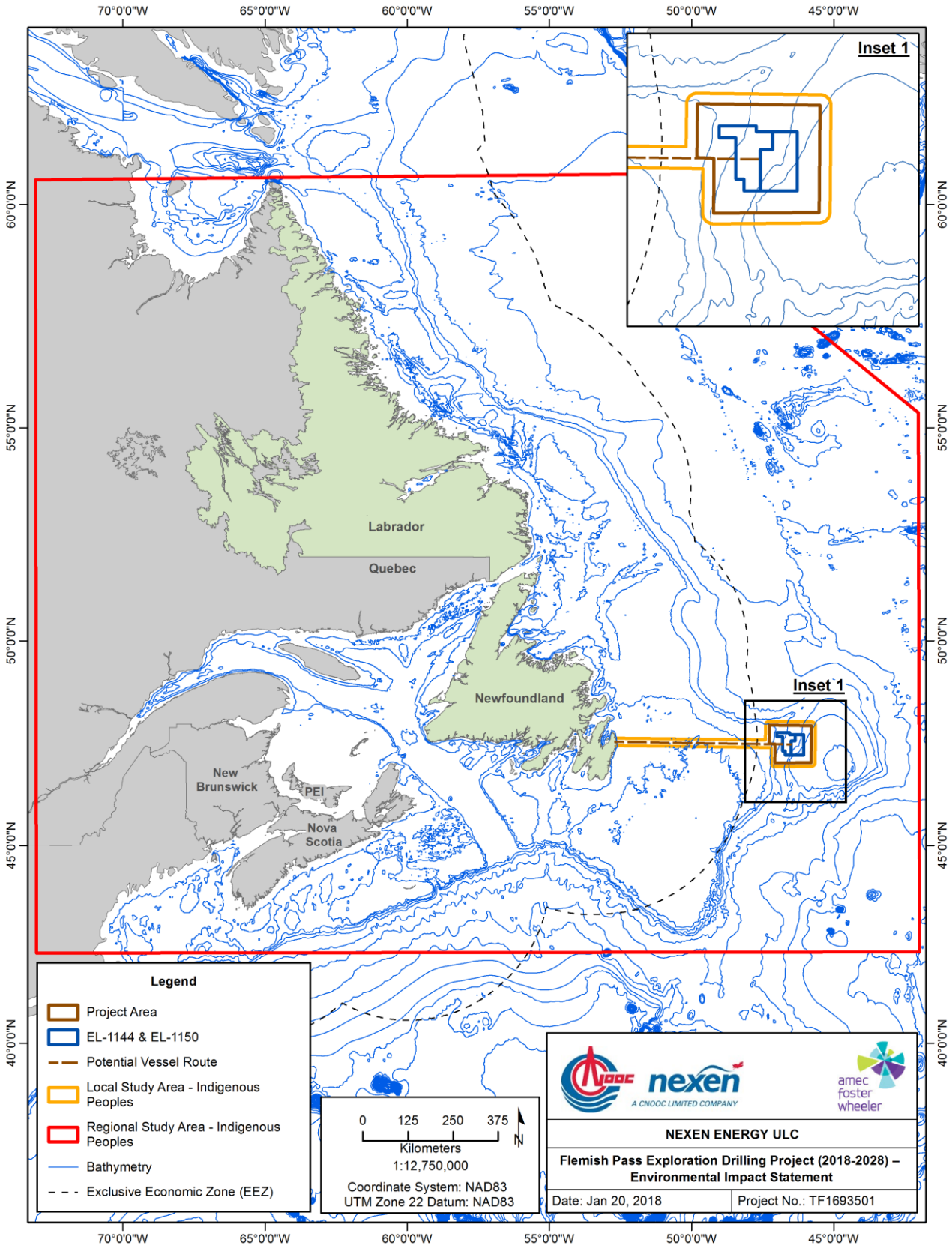
A number of spatial assessment boundaries have been defined for the environmental effects assessment for this VC (Figure 12.1).

Project Area: This area encompasses the overall geographic area offshore Eastern Newfoundland within which all planned Project-related exploration activities will take place. This includes ELs 1144 and 1150, within which drilling will occur, as well as a surrounding 20 km buffer area to account for any ancillary activities (such as walk away VSP surveys) that may extend outside the boundaries of the ELs themselves. While the Project Area is defined as an overall polygon that encompasses all such activities over the course of the Project, the various activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's components and activities, and therefore, encompasses the overall geographic area over which all planned Project-related environmental interactions (including any emissions and other disturbances) are predicted to occur. As described in Section 2.5 and in the preceding VC assessments (Chapters 8 to 10), these are expected to occur primarily within the overall Project Area polygon defined above, with the exception of Project activities that could conceivably occur on the edges of the Project Area boundary. For this VC, the LSA is therefore (conservatively) defined as the Project Area and the associated vessel and aircraft traffic route, and an approximately 10 km area around these.

Regional Study Area (RSA): In addition to these planned Project- and disturbance-related factors, the environmental effects assessment for this VC also recognizes and considers the spatial distribution and overall geographic extent of the various Indigenous groups under consideration, including their communities and activities, as well as the distribution and movements of the various marine-associated resources that are used for traditional purposes. The RSA for this VC therefore includes the overall Atlantic Canada region, encompassing the Indigenous communities and their activities throughout relevant parts of Newfoundland and Labrador, the Maritime Provinces and Quebec.

Figure 12.1 Indigenous Peoples: Environmental Assessment Study Areas



12.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the potential duration of Project-related activities in the Project Area (2018-2028, see Section 2.7), as well as the likely timing of any resulting environmental effects. In conducting the assessment, special consideration is also given to any particularly important or sensitive periods for the environmental and socio-cultural features, processes and activities that comprise or are associated with this VC.

12.1.3 Environmental Effect Significance Definitions

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects on this VC and their significance are assessed and evaluated.

Significant environmental effects for this VC are defined as those that would result from the Project and cause one or more of the following:

- *A negative change in the overall nature, location or timing of current land and resource use activities for traditional purposes by one or more Indigenous groups, resulting in a detectable and sustained reduction in overall activity levels.*

- *A reduction in the quality of ambient air, water, fish, wildlife or other resources at concentrations predicted to result in unacceptable human health risks, with an associated and detectable increase in the incidence of health issues.*

- *Adverse effects on the social health and well-being and other socioeconomic conditions of affected Indigenous communities, such that there are associated, detectable and sustained decreases in the real or perceived quality of life of a population.*

- *A decrease in established employment and business activity in one or more economic sectors such that there is a detectable adverse effect upon the economy of the affected Indigenous community over multiple years, and/or*

- *The destruction or disturbance of a structure, site or thing that is of historical, archaeological, paleontological or architectural significance to an Indigenous community without the appropriate documentation or salvage and retrieval of the cultural material and/or the information it contains, and without prior approval from the relevant regulatory authority.*

12.2 Potential Environmental Changes, Effects and Associated Parameters

A project EA first examines any changes to the environment that may be caused by the project that is under assessment, and then subsequently considers how these changes to the environment may affect the VC in question or aspects of it, such as heritage or any structure, site or thing (Canadian Environmental Assessment Agency 2015a). Changes to the environment as a result of offshore oil and gas exploration activities and their potential, resulting effects on Indigenous peoples may be both direct and indirect in nature and cause.

In terms of potential direct effects, the conduct of such exploration activities within Indigenous communities or in areas that are used by or otherwise important to these groups may result in reduced access to areas and resources due to required, safety-related access restrictions for defined periods (see Sections 2.5, 13.2, 13.3). Project-related components and their "footprints" and other environmental disturbances, such as noise, light, air and water emissions, could also extend to and affect components of the environment that are used by or otherwise important to Indigenous peoples. This may, in turn, have implications for these communities and their health and well-being (physical or social), heritage and other socioeconomic characteristics. Indirect effects can also occur when projects and activities adversely affect fish, wildlife or other environmental components and systems, as these biophysical effects may, for example, reduce the availability or perceived quality of such resources and thus their use and value for traditional purposes.

The EIS Guidelines identify a number of issues and potential effects which require consideration in the EIS (see Section 6.3.7). These focus on the various environmental changes and effects that are required under Section 5(1)(c) of CEAA 2012 (See detailed listing of these requirements and associated EIS Table of Concordance at the beginning of this EIS).

Nexen is committed to ensuring that Indigenous groups are appropriately informed and engaged regarding the company's planned activities. In the very early stages of EA initiation and the planning and preparation of this EIS, the Company contacted the following Indigenous groups to provide information on the Project and to seek initial input:

- Nunatsiavut Government;
- Innu Nation;
- NunatuKavut Community Council;
- Miawpukek First Nation;
- Qalipu Mi'kmaq First Nation Band; and the
- Mi'kmaq Alsumk Mowimsikik Koquey Association

This included writing to each group in March 2017 to provide an initial notification of the Project, and an opportunity for them to ask questions or provide comments regarding the Project and its potential environmental effects for consideration in the EA, as well as inviting further information sharing and engagement as the EA review progressed (see Section 3.3).

In April 2017, the Agency provided guidance to several other operators proposing similar exploration drilling programs off Eastern Newfoundland that additional Indigenous groups needed to be considered and engaged as part of the federal EA reviews of those projects. Nexen contacted these additional groups in July 2017 to introduce the Project and seek input.

Nova Scotia

- 11 Mi'kmaq First Nation groups represented by Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO):
  - Acadia First Nation
  - Annapolis Valley First Nation
  - Bear River First Nation
  - Eskasoni First Nation
  - Glooscap First Nation

  - Membertou First Nation
  - Paqtnkek Mi'kmaw Nation
  - Pictou Landing First Nation
  - Potlotek First Nation
  - Wagmatcook First Nation
  - Waycobah First Nation
- Millbrook First Nation
- Sipekne'katik First Nation

New Brunswick

- Eight Mi'gmaq First Nations groups represented by Mi'gmawe'l Tplu'taqnn Inc. (MTI)
  - Fort Folly First Nation
  - Eel Ground First Nation
  - Pabineau First Nation
  - Esgenoôpetitj First Nation
  - Buctouche First Nation
  - Indian Island First Nation
  - Eel River Bar First Nation
  - Metepnagiag Mi'kmaq First Nation
- Elsipogtog First Nation
- Five Maliseet First Nation groups represented by Wolastoqey Nation of New Brunswick (WNNB)
  - Kingsclear First Nation
  - Madawaska Maliseet First Nation
  - Oromocto First Nation
  - Saint Mary's First Nation
  - Tobique First Nation
- Woodstock First Nation
- Peskotomuhkati Nation at Skutik (Passamaquoddy)

Prince Edward Island

- Abegweit First Nation
- Lennox Island First Nation

Quebec

- Three Mi'gmaq First Nation groups represented by Mi'gmawei Mawiomi Secretariat (MMS)
  - Micmas of Gesgapegiag
  - La Nation Micmac de Gespeg
  - Listuguj Mi'gmaq Government
- Les Innus de Ekuanitshit
- Montagnais de Nutashkuan

These initial letters were followed by a number of subsequent engagement initiatives throughout the preparation of the EIS, an overview of the nature, intent and results of which were described in detail in Chapter 3. This included a second letter in November 2017 to follow-up on the introductory correspondence, and to request information related to any relevant traditional land and resource use activities and traditional knowledge. These letters were subsequently followed up with telephone calls and emails to each group, and the provision of further information and opportunities for discussion, as

required and requested. As referenced in the sections that follow, this included the preparation and provision of summary reports referencing research pertaining to Atlantic salmon populations and migrations, as this species was identified as a key area of concern by several groups.

As noted in Chapter 3, Nexen is committed to continuing meaningful communication and engagement with potentially affected Indigenous groups to keep them informed and engaged regarding the company's planned and on-going activities. Given the distance of the Project (over 600 km from the closest Indigenous community, see Section 7.4) from the various Indigenous groups identified above, much of the engagement has focused on potential effects to migratory species and the environment generally, during both planned Project activities and in the unlikely event of a large accidental event, such as an oil spill.

In addition, the Agency's above referenced notifications to other operators in April 2017 and July 2017 that they must consider additional Indigenous groups in Eastern Canada made specific reference to "the migration of Atlantic salmon between the Project area and areas where Indigenous groups have potential or established section 35 rights, and commercial-communal swordfish licences held by Indigenous groups within North Atlantic Fisheries Organization (NAFO) divisions, which overlap with the Project area". These issues were also raised in Nexen's engagement program involving several of these groups, as summarized in Section 3.3. For Indigenous groups, the analysis that follows includes a focus on the potential effects of the Project on Atlantic salmon populations that are currently used for traditional purposes, commercial swordfishing activity by some communities pursuant to their commercial-communal swordfish licences, as well as other species used by or otherwise important to these groups, as identified through engagement or a review of available information (see Section 12.3).

Through Nexen's engagement with Indigenous Groups, as described in Chapter 3, input was provided which resulted in further definition of the scope of the EIS to capture additional concerns and interests of the Indigenous Groups. This includes considerations related to the potential environmental effects (CEAA 2012 5(1)(c)) that the Project may have on Indigenous groups as well as the possible impacts to asserted or established Aboriginal and Treaty rights. Some of these interests and concerns include additional fish species (beyond Atlantic salmon or swordfish) of commercial, cultural and/or subsistence importance, such as American eel, as well as species of cultural significance, such as the North Atlantic right whale. In some cases, an Indigenous group referenced the importance of all species to the community from a commercial and traditional perspective. During ongoing engagement with Indigenous groups, and within the EIS, Nexen has considered these additional interests and concerns by responding directly to groups and ensuring the interests and concerns are addressed within the appropriate sections of the EIS (e.g. marine fish and fish habitat, marine and migratory birds, marine mammals).

The environmental effects assessment for this VC considers and focuses upon the various issues and questions identified through the above processes, including an initial identification of the key potential environmental changes and potential resulting environmental effects on the VC. These are summarized in Table 12.1 and have been used to focus and frame the environmental effects assessment.

Table 12.1 Potential Project-Related Environmental Changes and Resulting Effects: Indigenous Peoples

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• In terms of physical health, exploration drilling and associated activities will result in environmental emissions that may result in changes to the nature and quality of, air, water or consumed fish and wildlife. • With sufficient types, levels and durations of exposure, environmental contaminants may affect the physical health of persons who come into contact with these (either directly or indirectly). • In terms of social health and other socioeconomic components and characteristics, Project components and activities may interact with Indigenous peoples directly or indirectly (such as through noise, light, visibility, access restrictions) which can result in environmental changes that may have an adverse effect on perceptions of quality of life and well-being.	*Change in Health and Socio-Economic Conditions*	• Air and water quality • Quality and availability of utilized marine–associated resources • Types and incidences of physical health issues in a community / population • Perceived quality of life and well-being
• In any cases where Indigenous groups and their current land and resource use for traditional purposes occurs within or near the Project Area / LSA, these may be affected by Project-related environmental changes (disturbances and access restrictions) that may make certain areas / times unsuitable, or undesirable for these activities, with a resulting effect on the nature and value of these activities for the group. • Any biophysical environmental changes and resulting effects that influence the availability or quality of the water, air, vegetation, fish, wildlife or other resources used by these peoples may also indirectly affect these groups and their activities.	*Change in the Current Use of Lands and Resources for Traditional Purposes*	• Land / marine areas, times and resources available and used for traditional activities by each group • Nature, location, timing and frequency of traditional land and resource use activities by each group • Overall community participation rates in traditional land and resource activities • Degree of cultural value / fulfillment associated with traditional land and resource activities by a community
• Physical heritage components may be damaged or destroyed if they are present within the Project "footprint" or otherwise come into contact with Project related components, activities	*Change in Physical and Cultural Heritage* and	• Number of structures, sites or things of historical, archaeological, paleontological or architectural significance lost or disturbed

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
or emissions and associated environmental changes. • Aspects of cultural heritage, including both tangible (such as artifacts, structures) and intangible (traditions, language and knowledge) components, may be affected by direct and indirect environmental changes resulting from projects and other activities.	*Change in any Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance*	• Degree of cultural value associated with an identified aspect of physical / cultural heritage (tangible, intangible or otherwise) by a community

An overview of the potential for each of the Project's planned components and activities to result in one or more of the above noted potential environmental effects on this VC is presented in Table 12.2.

Table 12.2 Potential Project-VC Interactions and Associated Effects: Indigenous Peoples

Project Component / Activity	Potential Environmental Effects *		
	Change in Health and Socio-Economic Conditions	**Change in the Current Use of Lands and Resources for Traditional Purposes**	**Change in Physical and Cultural Heritage** and **Change in any Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●	●
Drilling and Associated Marine Discharges (including fluids and cuttings)	●	●	●
Vertical Seismic Profiling		●	
Well Testing	●	●	
Well Abandonment or Suspension		●	
Supply and Servicing	●	●	●
* Should these components of the VC be present within the Project Area / LSA			

In general, any Project components or activities that are expected to result in changes in access to lands and resources, emissions to the atmospheric or marine environments, or other disturbances have the potential to affect Indigenous communities and their activities where these occur within or near the Project Area and its expected environmental zone of influence (LSA). These possible interactions and potential effects have therefore been brought forward into the environmental effects assessment for further analysis.

12.3 Environmental Effects Assessment and Mitigation

12.3.1 Approach and Methods

The assessment of potential Project effects on this VC included a general approach of "overlaying" the planned Project components and activities (Chapter 2) and the predicted environmental zones of influence associated with these (as defined through the LSA) with what is known about the nature and location of Indigenous peoples and their communities, activities and interests. In doing so, the identified interactions and potential effects on the VC were analysed, the need for mitigation considered, and the significance of any residual effects determined and evaluated.

A variety of information sources were used to understand and describe the various Indigenous groups under consideration and their associated activities and interests that may be relevant to the Project (Section 7.4). As described in Chapter 3, Nexen has engaged and continues to do so with each of the identified Indigenous groups, including the early provision of Project-related information, as well as offers of further discussions and information sharing through various processes as the EA progresses. These have been intended to help obtain additional information and clarification on Indigenous groups and their activities and interests, any relevant Indigenous knowledge, and community issues and concerns regarding the Project and its potential environmental effects, for consideration and incorporation into the EIS. Where Indigenous groups have chosen to participate in such initiatives, the information and insights obtained through these processes has been valuable and were considered and incorporated throughout the EIS wherever relevant. In other cases, the EIS has been conducted on the basis of existing and publicly available sources of information. Nexen respects the views and wishes of the communities in that regard, and has continued to be open to discussion and cooperation with groups. It also encourages potentially affected Indigenous groups to provide any relevant input and information that they may have as part of their involvement in EA-related engagement processes and opportunities provided by the Agency.

12.3.2 Summary of Key Mitigation

The consideration of environmental issues from the earliest stages of Project planning and design is an important and fully integrated part of Nexen's approach to its proposed exploration and other business activities, including this Project. This approach allows potential environmental issues to be identified early, so that they can be considered and addressed in a proactive manner through appropriate Project planning and design. The objective is to attempt to avoid adverse environmental effects where possible and practical, or at least, to put in place mitigation measures to ensure that they are maintained at acceptable levels.

The primary Project characteristic that will reduce the likelihood of environmental effects on this VC is the large distance between planned Project components and activities and the various Indigenous communities under consideration and their known activities and interests. The various mitigation measures outlined elsewhere in this EIS will also serve to avoid or reduce any Project-related environmental emissions and disturbances (including the nature, degree, extent and duration of these), and thus further reduce the potential for these to interact with and adversely affect the various components and activities that comprise this VC.

12.3.3 Environmental Effects Assessment (All Planned Components and Activities)

This section assesses and evaluates the potential effects of the Project's planned components and activities on Indigenous peoples, including the various socio-cultural components and activities specified in Section 5(1)(c) of CEAA 2012.

12.3.3.1 Health and Socio-Economic Conditions

The various planned components and activities associated with this Project are not predicted to have any adverse effects upon the health or socioeconomic conditions of Indigenous peoples.

As described throughout this EIS (see Chapter 2 in particular), the Project will be characterized by standard marine activities and practices (both exploration and associated supply and service activities). These will occur within localized areas over short periods, and are subject to standard and effective regulatory requirements and associated mitigations that avoid or reduce their environmental emissions and potential effects. Moreover, all Project-related exploration activities will take place in the far offshore marine environment, over 400 km from any community or population and over 600 km from any Indigenous community. As described in Chapters 8 to 10, the Project is not predicted to result in significant adverse environmental effects on marine fish, birds, mammals or sea turtles, and thus, on the overall presence, distribution, and quality (real or perceived) of these resources. The geographic extent of any Project-related environmental emissions and other disturbances are also expected to be localized, and thus, are not expected to extend to or affect the health (physical or social) or well-being of any Indigenous peoples.

Planned Project activities are therefore not predicted to interact directly with Indigenous peoples or their communities. The Project and any associated environmental changes that may result from it will occur offshore, hundreds of kilometers from Indigenous communities and their on-land or near-shore activities and interests. It will therefore not overlap directly with any relevant socioeconomic components or activities, and given its offshore location will not likely be seen or heard by anyone. It will also not place direct or indirect demands on (and thus have implications for the availability and quality of) community services and infrastructure within or used by Indigenous peoples and their communities, nor will it result in any other types of adverse social and economic effects.

12.3.3.2 Current Use of Lands and Resources for Traditional Purposes

This section assesses the potential for the Project's predicted effects to extend to areas and resources that are used for traditional purposes by Indigenous groups. This includes the possibility of marine-associated fish and wildlife resources that are used by Indigenous groups to be affected by Project-related emissions and disturbances. The potential effects of the Project on any commercial (non-traditional) fishing activities undertaken by Indigenous groups are addressed as part of the fisheries and other ocean uses VC (Chapter 13).

The term "traditional uses" often refers to the practices, traditions and customs that define and distinguish the distinctive culture of an Indigenous people, and which were practiced prior to European contact. These "uses of lands and resources" can include, for example, hunting, fishing and gathering food for subsistence and ceremonial purposes, as well as associated time on and travel across the land, associated ceremonies and customs, cultural practices, and other tangible and intangible activities

and values (Canadian Environmental Assessment Agency 2015b). In addition, "current use for traditional purposes" is defined as:

> *Uses by Indigenous peoples that are actively being carried out at the time of the assessment and uses that are likely to occur in a reasonably foreseeable future provided that they have continuity with traditional practices, traditions or customs*
>
> *Traditional purposes typically relates to activities that are integral to a community's way of life and culture, and have continuity with historic practices, customs and traditions of the community* (Canadian Environmental Assessment Agency 2015b).

The term "current use of lands and resources" is also often expressed by Indigenous groups as being analogous to "aboriginal rights" or "treaty rights" (Canadian Environmental Assessment Agency 2015b). Section 35 of the *Constitution Act, 1982* recognizes and affirms the existing Aboriginal and Treaty Rights of the Indian, Inuit, and Métis peoples of Canada, the nature, scope and existence of which have been further defined through various legal decisions as well as through Land Claims Agreements between governments and particular Indigenous groups in specific areas.

It is recognized that several Indigenous Groups claim Aboriginal Rights and/or Title to areas of Newfoundland and Labrador, and the rights assertions and land claims of several groups residing in the Labrador portion of the province are in varying stages of progress, negotiation, and settlement. This includes the Labrador Inuit (*Labrador Inuit Lands Claims Agreement* finalized and in effect for the treaty area in Northern Labrador), Labrador Innu (*Land Claims Agreement-in-Principle* concluded, with associated land selection in Labrador completed), and the NunatuKavut Community Council whose land claim application covers much of Southern Labrador but has not been accepted for negotiation by the Governments of Canada or Newfoundland and Labrador. Mi'kmaq First Nations also reside on the Island of Newfoundland, including the Miawpukek First Nation which is based on the Samiajij Miawpukek Reserve in the Bay D'Espoir area in the southern part of the Island (located 635 km from the western boundary of the offshore part of the Project Area) and the Qalipu First Nation Band, a landless band whose members reside in 66 communities across the Island of Newfoundland. In addition, each of the previously identified Indigenous groups in New Brunswick, Nova Scotia, PEI and Quebec assert and/or have established rights to specific lands and resources within their claimed traditional territories, which are likewise at varying stages of recognition and settlement. Although the traditional territories of these groups are not known to extend to the Eastern Newfoundland Offshore Area, it is acknowledged that several groups in the Maritime Provinces hold commercial-communal licences for species such as swordfish that include various NAFO Divisions that encompass the Project Area and LSA (Section 7.4).

The EIS Guidelines include requirements to assess "potential adverse impacts on potential or established Aboriginal or treaty rights protected under section 35 of the *Constitution Act, 1982*" (EIS Guidelines Section 2.3). As discussed and illustrated in Section 7.4, planned Project components and activities will be located over 600 km from any Indigenous peoples and their communities, and from the traditional territories and activities associated with each of these groups. Based on the information available to the Proponent and used and summarized in this EIS (Section 7.4), Nexen is not aware that these or any other Indigenous groups hold, claim or assert Aboriginal or Treaty rights or otherwise undertake traditional activities within or near the Project Area or LSA, pursuant to Section 35 of the *Constitution Act, 1982*.

Indigenous Commercial Fish Harvesting

Although fishing enterprises associated with several of these organizations undertake commercial fishing activity within NAFO Divisions that overlap parts of the LSA (Section 7.2.5) , it is understood that these fishing activities occur through commercial licences issued by the federal government under the *Fisheries Act* and its associated *Aboriginal Communal Fisheries Licencing Regulation*, as well as other government policies and strategies that are designed to involve Indigenous peoples and communities in commercial fisheries in Canada. As “traditional use” is again generally understood to mean activities that have been exercised by an identifiable Indigenous community since the time of European contact or control of a specific area, these contemporary, commercial land and resource use activities may not be considered traditional in that they are not a continuation of ancestral activities that took place historically within this area offshore Eastern Newfoundland. Specifically, given the location of the Project Area from the Indigenous groups (over 400 km from land, and 635 km from the closest Indigenous community) it is unlikely that traditional fish harvesting activities took place in the LSA. The potential effects of the Project on commercial (non-traditional) fishing activity are assessed and evaluated in Chapter 13 of this EIS.

Indigenous Subsistence Harvesting

The Project’s planned components and activities and their various environmental emissions and potential disturbances will be localized and limited to within the LSA. These will not directly interfere or otherwise interact with the current use of lands and resources for traditional purposes by any Indigenous peoples. The Project will therefore not have any adverse effects on such activities as they do not occur within or near the LSA at any time of the year. For those groups in the Maritime Provinces that hold commercial-communal licences for swordfish in NAFO Divisions that overlap the LSA, a further analysis is provided in a separate subsection later in this chapter.

In terms of potential indirect effects on such activities, the environmental effects assessment also considers whether and how any Project-related changes in the biophysical environment within the LSA may affect resources that are used for traditional purposes by Indigenous groups as a result of the migrations and movement patterns of these species. In particular, the assessment considers whether any marine-associated species that are known to be used for traditional purposes by these groups migrate through the LSA and may therefore be affected by the Project, with possible resulting implications for their eventual availability or perceived quality for traditional harvesting and consumption by these groups.

Tables 12.3 to 12.6 provide a listing of the various species that have been identified as being used by each Indigenous group. This includes those that have been identified through the review of existing, published information sources (Section 7.4), as well as those identified by individual groups as part of Nexen’s engagement program (Chapter 3). In terms of the latter, some of these interests and concerns include migrating species of commercial, cultural and/or subsistence importance, such as Atlantic salmon, swordfish, American eel, migratory birds and seals, as well as species of cultural significance, such as the North Atlantic right whale. A number of Indigenous groups also sought additional information on the potential effects of the Project on other commercial species, such as cod, turbot and snow crab. In some cases, an Indigenous group referenced the importance of all species to the community from a commercial and traditional perspective.

During its ongoing engagement with Indigenous groups, Nexen has considered these identified interests and concerns and addressed them within the appropriate effects assessment sections of the EIS (e.g. marine fish and fish habitat, Chapter 8; marine and migratory birds, Chapter 9, marine mammals, Chapter 10).

Table 12.3 Identified Marine-Associated Species: Newfoundland and Labrador Indigenous Groups

Species		Newfoundland and Labrador Indigenous Groups				
		Labrador Inuit	**Labrador Innu**	**NunatuKavut Community Council**	**Qalipu Mi'kmaq First Nation**	**Miawpukek First Nation**
Fish and Shellfish	Arctic char	●	●	●		
	Atlantic cod			●		●
	Atlantic salmon	●	●	●	●	
	Atlantic halibut		●			
	Bluefin tuna					●
	Brook trout				●	●
	Capelin	●	●	●	●	●
	Clam	●				
	Cod	●	●	●		●
	Crab	●				
	Eel				●	●
	Greenland halibut	●	●			
	Groundfish	●	●	●	●	●
	Haddock		●			
	Herring			●	●	●
	Lobster				●	●
	Mackerel		●		●	●
	Mussel	●				
	Rainbow trout				●	●
	Redfish					●
	Rock cod	●		●		
	Sculpin	●				
	Sea cucumber					●
	Sea urchin	●				
	Scallop	●		●	●	●
	Shrimp	●	●	●	●	
	Skate		●			
	Smelt	●		●	●	●
	Snow crab	●			●	●
	Squid				●	●
	Swordfish					●
	Toad crab					
	Trout	●	●		●	
	Tuna					●
	Turbot	●				
	Whelk				●	●
	White hake		●			

Species		Newfoundland and Labrador Indigenous Groups				
		Labrador Inuit	**Labrador Innu**	**NunatuKavut Community Council**	**Qalipu Mi'kmaq First Nation**	**Miawpukek First Nation**
	Winkle					
Birds and Eggs	Black duck	●				
	Black scoter	●				
	Canada goose	●				
	Common eider	●	●			
	Common eider eggs	●				
	Duck		●			
	Goose		●			
	Gull eggs	●				
	Guillemot eggs	●				
	Loon	●				
	Merganser	●				
	Migratory birds		●		●	
	Murre	●	●			
	Scoter	●				
	Sea duck	●	●			
	Surf Scoter	●				
	Tern eggs	●				
	White-winged Scoter	●				
Marine Mammals	Bearded seal	●				
	Harbour seal	●				●
	Harp seal	●			●	●
	Grey seal	●			●	●
	Ringed seal	●				
	Seal	●	●	●	●	●

Table 12.4 Identified Marine-Associated Species: Nova Scotia Indigenous Groups

Species		Nova Scotia Indigenous Group												
		Acadia	**Annapolis Valley**	**Bear River**	**Eskasoni**	**Glooscap**	**Membertou**	**Paqtnkek**	**Pictou Landing**	**Potlotek**	**Wagmatcook**	**Waycobah**	**Millbrook**	**Sipekne'katik**
Fish and Shellfish	Atlantic salmon	●	●	●	●	●	●	●	●	●	●	●	●	●
	Bar clam			●										●
	Blue shark	●												
	Blueback herring	●												
	Brook trout	●												
	Brown trout		●										●	

Species	Nova Scotia Indigenous Group												
	Acadia	Annapolis Valley	Bear River	Eskasoni	Glooscap	Membertou	Paqtnkek	Pictou Landing	Potlotek	Wagmatcook	Waycobah	Millbrook	Sipekne'katik
Capelin									●				
Clam		●		●		●	●				●	●	
Cod	●		●	●		●	●		●	●	●		
Crab	●	●	●	●		●			●	●		●	●
Eel	●	●	●	●	●	●	●		●	●	●	●	●
Flounder		●		●	●	●			●	●	●		
Gaspereau	●	●	●	●	●	●			●	●		●	●
Groundfish	●	●	●	●		●			●	●		●	●
Haddock	●			●	●	●	●		●	●	●		
Hagfish												●	
Halibut	●	●			●	●							
Herring		●	●	●		●	●		●	●	●	●	●
Lobster	●	●	●	●	●	●		●	●	●	●	●	●
Mackerel	●	●	●	●	●	●	●		●	●	●	●	●
Mussel	●	●	●	●	●	●	●		●	●	●		●
Oyster						●	●					●	
Periwinkle	●												
Pollock	●	●			●	●			●	●	●		
Quahaug	●		●	●		●			●		●	●	●
Rainbow trout	●	●										●	
Razor clam	●		●										●
Scallop	●	●	●	●	●	●			●	●	●	●	●
Sea urchin						●	●		●	●		●	●
Shad	●	●	●	●	●				●	●	●		●
Shrimp				●		●			●				
Smelt	●	●	●	●	●	●			●	●	●	●	●
Snow Crab							●					●	
Soft-shelled clam	●		●		●				●				●
Speckled trout												●	
Squid	●									●			
Striped bass	●		●		●	●	●	●	●	●		●	●
Swordfish						●		●		●		●	●
Tomcod	●												
Trout			●	●	●	●		●	●	●	●		●
Tuna			●			●		●	●	●	●	●	●

Species		Nova Scotia Indigenous Group												
		Acadia	Annapolis Valley	Bear River	Eskasoni	Glooscap	Membertou	Paqtnkek	Pictou Landing	Potlotek	Wagmatcook	Waycobah	Millbrook	Sipekne'katik
Marine Mammals	Seal	●		●							●			

Table 12.5 Identified Marine-Associated Species: New Brunswick Indigenous Groups

Species		New Brunswick Indigenous Group														
		Fort Folly	Eel Ground	Pabineau	Esgenoôpetitj	Buctouche	Indian Island	Eel River Bar	Metepenagiag Mikmaq	Elsipogtog	Kingsclear	Madawaska Maliseet	Oromocto	Saint Marys	Tobique	Woodstock	Peskotomuhkati*
Fish and Shellfish	Atlantic salmon		●	●	●	●	●	●	●	●	●	●	●	●		●	●
	Brook trout		●		●	●			●			●					
	Clam		●	●	●	●	●			●							
	Crab			●	●						●	●					
	Eel	●	●		●	●	●		●	●			●	●		●	●
	Gaspereau	●	●				●		●	●			●	●			●
	Groundfish	●			●			●			●	●	●	●	●	●	
	Herring	●	●	●	●		●	●	●	●	●	●	●	●	●		
	Lobster	●		●	●		●	●	●	●	●	●	●	●	●	●	
	Mackerel		●	●	●	●	●		●	●		●		●	●		
	Mussel		●	●	●		●			●							
	Oyster		●	●	●	●	●		●	●							
	Pollock																●
	Quahaug		●		●		●			●					●		
	Rock crab						●	●	●	●							
	Scallop	●		●	●		●		●	●	●	●	●	●	●	●	
	Sea urchin										●		●	●	●	●	
	Shad		●						●	●		●	●	●			
	Shrimp												●	●			
	Snow crab			●	●		●		●	●							
	Smelt		●		●		●			●				●		●	
	Soft-shelled clam				●		●	●		●				●			
	Striped / smallmouth		●		●	●	●	●	●	●	●		●	●	●	●	

Species		New Brunswick Indigenous Group															
		Fort Folly	**Eel Ground**	**Pabineau**	**Esgenoôpetitj**	**Buctouche**	**Indian Island**	**Eel River Bar**	**Metepenagiag Mikmaq**	**Elsipogtog**	**Kingsclear**	**Madawaska Maliseet**	**Oromocto**	**Saint Marys**	**Tobique**	**Woodstock**	**Peskotomuhkati***
	bass																
	Sturgeon												●				
	Swordfish												●			●	
	Trout			●	●		●			●		●			●		
	Tuna	●		●	●	●	●	●		●			●	●	●		
Marine Mammals	Seal									●							
Marine Plants	Unspecified				●					●							
* Historical information only																	

Table 12.6 Identified Marine-Associated Species: PEI and Quebec Indigenous Groups

Species		PEI and Quebec Indigenous Groups						
		PEI		**Quebec**				
		Abegweit	**Lennox Island**	**Micmas of Gesgapegiag**	**Listuguj Mi'gmaq Government**	**La Nation Micmac de Gespeg**	**Les Innus de Ekuanitshit**	**Montagnais de Nutashkuan**
Fish and Shellfish	Atlantic salmon	●	●	●	●	●	●	●
	Clam	●	●					
	Cod			●		●		
	Crab			●				
	Eel	●	●	●	●	●		
	Gaspereau	●	●					
	Groundfish		●					
	Herring	●	●	●				
	Lobster	●	●	●	●			●
	Mackerel	●	●	●		●		
	Mussel	●	●					
	Oyster	●	●					
	Quahaug	●	●					
	Rock crab	●	●					
	Scallop	●						●
	Sea trout							●
	Silverside	●						

Species		PEI and Quebec Indigenous Groups						
		PEI		Quebec				
		Abegweit	Lennox Island	Micmas of Gesgapegiag	Listuguj Mi'gmaq Government	La Nation Micmac de Gespeg	Les Innus de Ekuanitshit	Montagnais de Nutashkuan
	Smelt	●	●	●	●			
	Striped bass	●		●	●			
	Swordfish	●	●					
	Toad crab	●						
	Trout	●	●	●	●	●	●	
	Tuna	●	●					
Birds and Eggs	Duck					●	●	
	Goose						●	
	Loon					●	●	
	Merganser						●	
	Waterfowl			●				
	Birds eggs						●	●
Marine Mammals	Otter						●	●
	Seal	●	●			●	●	

Table 12.7 provides a summary evaluation of whether, based on existing and available scientific literature, individuals from these identified species are known or likely to be present within the LSA at any time of year before making their way into known areas of traditional use by one or more Indigenous peoples. Given the total size of the area of Eastern Newfoundland through which the overall LSA (including the vessel traffic route) extends, and the fact that most if not all potential for material interactions between Project activities and these species will be in relation to the planned offshore activities (especially, drilling), the analysis that follows focusses primarily on the offshore components of the LSA, namely, that which surrounds the ELs themselves.

Table 12.7 Identified Species and their Potential for Interaction with the Project (LSA Occurrence)

Species		Potential for These Resources to Spend Time Within the LSA
Marine Fish and Shellfish	Arctic char	• Do not occur in LSA, searun populations remain close to natal river (Scott and Scott 1988).
	Atlantic cod	• Occasional presence in LSA, inhabits offshore shelf areas in winter and inshore areas in summer (Scott and Scott 1988). • Tagging studies indicate that individuals rarely move more than 500 km (COSEWIC 2010). • Resident offshore populations are distinct from inshore populations (Beacham et al 2002). • Individuals from the Flemish Cap typically will stay in the area, whereas there is some mixing between Northern Grand Banks cod and inshore cod on the east coast of NL (Beacham et al 2002).
	Atlantic salmon	• See later section, below
	Atlantic halibut	• Occasional presence in the LSA. Primarily found on southern shelf and slope areas off Atlantic Canada. Juveniles are known to migrate hundreds of kilometres, including from Labrador to western Greenland and from Newfoundland and Nova Scotia towards the Grand Banks (COSEWIC 2012).
	Bar clam (Atlantic Surfclam)	• Surfclams occur in the LSA. This species inhabits inshore and offshore shelf areas and rarely occurs on muddy substrates. Adults immobile with planktonic larvae (NOAA 1999; Snelgrove et al 1998).
	Blueback herring	• Do not occur in the LSA. Has long ocean migrations in coastal estuaries and open shelf waters to 200 m deep (Turner et al 2015; Froese and Pauly 2017).
	Blue shark	• Occasional presence in the LSA. Highly migratory species that may travel through LSA (COSEWIC 2016). Occurrence is primarily on the Grand Banks and south of the Flemish Cap.
	Bluefin tuna	• Occurs in LSA. May migrate through area during summer feeding migrations off the east coast of Canada. Individuals generally follow the warm Gulf Stream current eddies (Hsu et al 2015), travelling along the Grand Banks and to the Flemish Pass and Cap.
	Brook trout	• Do not occur in LSA, searun populations remain close to natal river (Scott and Scott 1988).
	Brown trout	• Do not occur in LSA, searun populations remain close to natal river (Scott and Scott 1988).
	Capelin	• Regular presence in LSA, inshore and offshore populations. Spawning population on the Southeast shoal of the Grand Banks (Scott and Scott 1988). Capelin stocks mix offshore and migrate towards the same bay for spawning or areas further north (Nakashima et al 1992). • Individuals occurring on the northern Grand Banks forage offshore and return in spring-summer to coastal areas in Newfoundland to spawn (Kenchington et al 2015).

Species		Potential for These Resources to Spend Time Within the LSA
	Clam	• Occurs in the LSA and elsewhere off Eastern Newfoundland, adults immobile (although dispersal over 10 km for planktonic larvae) (Beukema and de Vlas 1989).
	Cod	• Depending on species, occasional presence in LSA, inhabits offshore areas in winter and inshore areas in summer (Scott and Scott 1988). Resident offshore populations are distinct from inshore populations (Beacham et al 2002).
	Crab (General)	• Occur in parts of the LSA and elsewhere off Eastern Newfoundland, but with limited home ranges / movements by adult individuals (Christian et al 2010)
	Eel	• Occasional presence in LSA, adults migrate from coastal areas to the Sargasso Sea (Scott and Scott 1988). Adult individuals from the coast of North America would migrate following continental shelf areas (Wang and Tzeng 1998), reducing likelihood of passing through the LSA. • Larval would also migrate along the continental shelf areas from the Sargasso Sea to North American rivers.
	Flounder	• Regular presence in LSA, various groundfish species are present on the Grand Banks and Flemish Cap (Scott and Scott 1988). Population structure is generally divided into subpopulations for various groundfish species with divisions among coastal and offshore groups
	Gaspereau	• Alewife, do not occur in LSA. Primarily found in coastal areas near natal estuaries in waters 56-100 m deep (Froese and Pauly 2017).
	Greenland halibut	• Occurs in the LSA from shelf to deep waters. Individuals from the Grand Banks make large spawning migrations northward to the Davis Strait (Bowering 1984; Junquera and Zamarro 1994). • Adults in the Flemish Pass area may remain in the area for spawning (Junquera and Zamarro 1994).
	Groundfish	• Regular presence in LSA, various groundfish species are present on the Grand Banks and Flemish Cap (Scott and Scott 1988). Population structure is generally divided into subpopulations for various groundfish species with divisions among coastal and offshore groups
	Haddock	• Occasional presence in LSA on Grand Banks Shelf and Flemish Cap (NOAA 1999). Adults migrate offshore in autumn for spawning aggregations. • Primary spawning locations including the southern Grand Banks, St. Pierre Bank, Georges Bank, Browns Bank and Emerald-Western Banks occur outside the LSA (Begg 1998).
	Hagfish	• Occasional presence in the LSA (Mahon et al 1998). Primarily occurs on the Grand Banks Shelf.
	Halibut	• Occurring or occasionally occurring in the LSA. Juveniles and adults capable of long distance migrations. • See Atlantic halibut and Greenland halibut.
	Herring	• Regular occurrence in LSA, extensive annual migratory patterns to spawning grounds, overwintering areas and feeding

Species		Potential for These Resources to Spend Time Within the LSA
		areas (Scott and Scott 1988). There are a number of separate populations with each stock having preferred spawning grounds, feeding and wintering areas (Scott and Scott 1988). • Herring in Newfoundland waters migrate northwards out of bays for summer foraging and return during the fall for overwintering (Wheeler and Winters 1983).
	Lobster	• Distributed mainly in shallow (near shore) areas with some populations distributed on slope areas (110-145 m), larvae with high dispersal ability (Christian et al 2010).
	Mackerel	• Occasional presence in LSA, inhabits deeper water (70-200 m) on the continental shelf in winter. This species has pelagic larvae (Scott and Scott 1988). Main migration routes to spawning grounds mainly in the Gulf of St. Lawrence and the coastal areas of the Northeastern United States (Scott and Scott 1988).
	Mussel	• Do not occur in LSA, occurs primarily in intertidal and shallow subtidal areas, adults immobile, planktonic larvae prefer shallow settlement depths (Christian et al 2010).
	Oyster	• American oysters do not occur in the LSA. Distributed from the Gulf of St. Lawrence to the Gulf of Mexico. Low temperatures limit abundance to coastal areas (Pinhorn 1976).
	Periwinkle	• Do not occur in LSA, species depth limited to intertidal zone (Perez et al 2009).
	Pollock	• Occasional presence in the LSA, with a depth range of 37-364 m (Steele 1963). Primarily found on the western slope of the Grand Banks (Gomes et al 1992). • Migrations of pollock may follow migrations of prey species including herring and capelin (Armannsson et al 2007)
	Quahaug (Ocean Quahog)	• Do not occur in the LSA. Primarily inhabits subtidal areas from 20-150 m depth (Christian et al 2010).
	Rainbow trout	• Do not occur in LSA, searun populations remain close to natal river (Scott and Scott 1988).
	Razor clam	• Do not occur in LSA. Primarily inhabits the lower intertidal zone to the subtidal zone up to 35 m depth.
	Redfish	• Regular presence in LSA, well distributed on the Flemish Cap and Grand Banks from shallow depths to deep areas, planktonic larvae (Scott and Scott 1988). The Grand Banks and Newfoundland are genetically part of a single population (Roques et al 2002), however recruitment to offshore populations is mainly from Gulf of St. Lawrence nursery areas (Valentin et al 2016).
	Rock cod	• Do not occur in LSA, inhabits inshore regions and is less common offshore (Scott and Scott 1988).
	Rock crab	• Do not occur in LSA, primarily inhabits coastal areas less than 20 m depth (Christian et al 2010).
	Scallop	• Occurs throughout LSA and elsewhere off Eastern Newfoundland, mainly distributed in areas over 50 m deep,

Species		Potential for These Resources to Spend Time Within the LSA
		adult sea scallops and Icelandic scallops are immobile but with planktonic larvae (Christian et al 2010).
	Sculpin	• Occurs in the LSA and elsewhere off Eastern Newfoundland, especially in shallower water depths, but with limited home ranges / movements by individuals (Scott and Scott 1988; Gomes et al 1992).
	Sea cucumber (Orange footed sea cucumber)	• Orange footed sea cucumber may occur in LSA as this species has been observed at 110 m depths (Hamel and Mercier 1996). Long lived lecithotorphic larvae with high capacity for dispersal of approximately 800 km (So et al 2011).
	Sea trout	• Do not occur in LSA, searun populations remain close to natal river (Scott and Scott 1988).
	Sea urchin (Green sea urchin)	• Green sea urchins occur in the LSA and elsewhere off Eastern Newfoundland, adults immobile but planktonic larvae released in April-May are capable of travelling over large distances with currents (Addison and Hart 2004).
	Shad	• Do not occur in LSA. Observed coastally from Newfoundland to Florida at depths of 0-250 m.
	Shrimp	• Occurs in LSA primarily from 150-600 m in areas with soft, mud and silt substrate. Shrimp have a long (three month) pelagic larval phase that promotes dispersion (Christian et al 2010; Jorde et al 2015). • Northern shrimp are primarily distributed on the northeast shelf and slope and shelf areas off Newfoundland, north of the Avalon peninsula.
	Silverside	• Do not occur in LSA. Species distribution is along coastal waters to offshore from the Maritime Provinces to Florida (Clarke et al 2010).
	Skate	• • Occurs in LSA. These species found primarily at less than 800 m, but also observed at over 2,000 m (Murua and de Cardenas 2005) on the Newfoundland Shelf. • Adults and juveniles have relatively small home ranges (Chevrolot et al 2007) with tagging studies indicating ranges of 100 km and up to 440 km in thorny skate (COSEWIC 2012).
	Smelt	• Do not occur in LSA, as these are an estuarine species with limited dispersal among areas (Bradbury et al 2006; 2008).
	Snow crab	• Snow crab occur in parts of the LSA and elsewhere off Eastern Newfoundland, but with limited home ranges / movements by adult individuals of 52-262 km (Puebla et al 2008; Christian et al 2010, Mullowney et al 2017). • Adults with movements into shallower waters on the Grand Banks during the spring.
	Soft-shelled clam	• Occasional in LSA as commonly found from 3-60 m, but have been observed at depths of 200 m. Very limited movement by adults, but larvae are planktonic (Christian et al 2010).
	Speckled trout	• Do not occur in LSA, searun populations remain close to natal river (Scott and Scott 1988).

Species		Potential for These Resources to Spend Time Within the LSA
	Squid	• Occurs in LSA with seasonal inshore-offshore migrations to slope waters beyond the continental shelf (Christian et al 2010). • Shortfin squid migrate to the Grand Banks and Scotian shelf to feed with mature squid leaving the shelf in the fall to southwestern inshore areas in the south near Cape Hatteras off the coast of the US (Christian et al 2010).
	Striped bass	• Do not occur in LSA. Anadromous species that primarily occupies coastal marine areas. Distributed from the Gulf of Mexico to the southern Grand Banks (Froese and Pauly 2017)
	Sturgeon	• Do not occur in LSA. Distributed from Ungava Bay, Labrador, Gulf of St. Lawrence to Florida. Rarely recorded off the Island of Newfoundland (Wilson and McKinley 2004).
	Swordfish	• See later section, below
	Toad crab	• Occurs in LSA on slopes up to 700 m deep. Limited movement by adults, but larvae are planktonic (Christian et al 2010).
	Tomcod	• Do not occur in LSA. Coastal species that occurs from Southern Labrador to Virginia, USA at depths ranging from 0-69 m (Froese and Pauly 2017).
	Trout	• Do not occur in LSA, searun populations remain close to natal river (Scott and Scott 1988).
	Tuna	• Occurs in LSA. May migrate through area during summer feeding migrations off the east coast of Canada. Generally follows the warm Gulf Stream current eddies (Hsu et al 2015).
	Turbot (Greenland Halibut)	• Occurs in the LSA from shelf to deep waters. Individuals from the Grand Banks make large spawning migrations northward to the Davis Strait (Bowering 1984; Junquera and Zamarro 1994). • Adults in the Flemish Pass area may remain in the area for spawning (Junquera and Zamarro 1994).
	Whelk	• Potential occurrence in LSA, distributed from tidal depths to 180 m (Christian et al 2010), adults and larvae have low mobility, limiting dispersal.
	White hake	• Occurs within LSA, migrates to inshore waters in warmer months and migrates to offshore waters for colder months (COSEWIC 2013). • There are few seasonal changes in distribution of hake from Newfoundland. Hake from the maritimes are primarily in coastal waters in summer months, migrating to deeper water in the Cabot Strait in winter (COSEWIC 2013).
	Winkle (Periwinkle)	• Periwinkle do not occur in LSA, species depth limited to intertidal zone (Perez et al 2009).
Marine Birds and Eggs	Waterfowl (ducks and geese)	• See Ducks (general) and Canada goose.
	Ducks (general)	• Rare, seasonal (October to April) occurrence in LSA for Common Eider and Scoters (Goudie et al 2000; ECSAS 2016). • Individuals found in Labrador during breeding and migration overwinter further south, including open waters off Eastern Newfoundland, due to advancing pack ice and freeze-up of shallower inshore waters. Other species such as mergansers

		and American Black Duck are absent in offshore waters (Longcore et al 2000; Craik et al 2015; Pearce et al 2015).
	Sea duck (includes eiders, scoters)	• Rare, seasonal (October to April) occurrence in LSA for Common Eider and Scoters (Goudie et al 2000; ECSAS 2016). • Individuals found in Labrador during breeding and migration overwinter further south, including open waters off Eastern Newfoundland, due to advancing pack ice and freeze-up of shallower inshore waters; as migratory movements are generally southwards, individuals nesting in the Gulf of St. Lawrence and the Maritimes are unlikely to occur in the LSA.
	Scoters (general)	• All three scoter species are rare and seasonal (October to April) within the LSA. Refer to species accounts below for details on Black Scoter, Surf Scoter and White-winged Scoter range and movements.
	Black Scoter	• Rare, seasonal (October to April) occurrence in LSA (ECSAS 2016). • Scarce breeder in Labrador and Northern Quebec, but those that do so may overwinter off the coast of Newfoundland, the northernmost reported extent of the species' wintering range (Bordage and Savard 2011); as migratory movements are generally southwards, individuals nesting in the Gulf of St. Lawrence and the Maritimes are unlikely to occur in the LSA.
	Surf Scoter	• Rare, seasonal (October to April) occurrence in LSA (ECSAS 2016). • Individuals that breed in Labrador and Northern Quebec may pass through offshore Newfoundland during migration (Anderson et al 2015).
	White-winged Scoter	• Rare, seasonal (October to April) occurrence in LSA (ECSAS 2016). • Breeding not documented in Labrador and northern Quebec, but individuals migrate off the coast to and from wintering grounds. The northernmost extent of their wintering range is off Eastern Newfoundland (Brown and Frederickson 1997); as migratory movements are generally southwards, individuals nesting in the Gulf of St. Lawrence and the Maritimes are unlikely to occur in the LSA.
	Common Eider (adults and eggs)	• Rare, seasonal (October to April) occurrence in LSA (Goudie et al 2000). • Individuals breeding along the Labrador coast and northern Quebec often overwinter further south in open waters, due to advancing pack ice and freeze-up of shallower inshore waters (Goudie et al 2000); as migratory movements are generally southwards, individuals nesting in the Gulf of St. Lawrence and the Maritimes are unlikely to occur in the LSA.
	Mergansers (Common and Red-breasted)	• Does not occur in LSA. Found in near-shore habitats such as bays and estuaries (Craik et al 2015; Pearce et al 2015).
	American Black Duck	• Does not occur in LSA. • Breeds inland (near fresh water); outside breeding season, may occur in nearshore habitats including southern and

		western Newfoundland, the Maritime provinces and the Gaspe Peninsula (Longcore et al 2000).
	Canada Goose	• Does not occur in LSA. • Breeds inland (near fresh water); outside breeding season, may occur in nearshore (tidal) habitats including southern and western coasts of Newfoundland and parts of Nova Scotia (Mowbray et al 2002).
	Loons (Common and Red-throated)	• Rare occurrence in LSA, typically found in near-shore habitats outside breeding season (Barr et al 2000; Evers et al 2010). • Common Loons that breed in northern Quebec, Newfoundland and Labrador may overwinter off the coast of Newfoundland, as it is the closest extent of the species' wintering range; Red-throated Loon overwinters further south (Barr et al 2000; Evers et al 2010).
	Guillemots (adults and eggs)	• Rare occurrence in LSA during breeding season, as Black Guillemots are typically found in coastal areas. • Individuals from Labrador (and, likely, northern Quebec) overwinter in Gulf of St. Lawrence and off Eastern Newfoundland, typically found with pack ice; individuals breeding in the Gulf of St. Lawrence tend to winter south of the LSA (Butler and Buckley 2002).
	Murres (Common and Thick-billed)	• Regular occurrence in the LSA (ECSAS 2016). • Common and Thick-billed Murres overwinter in open water in the offshore environment where they disperse widely, and those breeding in northern areas (northern Quebec and Labrador) are often pushed southward by advancing ice (Gaston and Hipfner 2000; Ainley et al 2002). Therefore, there is potential for individuals nesting throughout Eastern Canada to be present in the LSA outside the breeding season.
	Gulls (eggs)	• Regular occurrence in LSA (ECSAS 2016). • Populations of the two most common species nesting in northern areas, the Herring Gull and Great Black-backed Gull, migrate south of their breeding grounds and may overwinter off Eastern Newfoundland (Good 1997; Nisbet et al 2017a); individuals nesting in the Maritime provinces and Gulf of St. Lawrence are unlikely to occur in the LSA.
	Terns (adults and eggs)	• Rare occurrence in LSA, typically in coastal areas, although Arctic Terns are found offshore during migration (seasonal, absent in winter) (ECSAS 2016). • Both Common and Arctic Terns nesting in Labrador and Northern Quebec have potential to pass through Eastern Newfoundland waters during southward migration (Hatch 2002; Nisbet et al 2017b); individuals nesting in the Maritime provinces and Gulf of St. Lawrence are unlikely to occur in the LSA.
Marine Mammals	Seals (General)	• Of the six species of seal known to occur in Newfoundland and Labrador, two are considered to have potential to occur within the LSA: harp seal and hooded seal (Stenson and Sjare 1997; Anderson et al 2009).

		• Harbour and grey seals are non-migratory, and tagging studies have shown they do not travel through the LSA (Lesage et al 2004; Harvey et al 2008). • Ringed and bearded seals are primarily Arctic species, rarely observed south of coastal Labrador (Gosselin and Boily 1994; DFO 2011).
	Bearded seal	• Unlikely to occur in LSA. Generally found along the Labrador coast, which is believed to be the southern limit of this species (Gosselin and Boily 1994). Sightings have been reported in the Gulf of St. Lawrence and along the northeast coast of Newfoundland (DFO 2011), but these are considered vagrants (Gosselin and Boily 1994; DFO 2011).
	Harbour seal	• Unlikely to occur in LSA. Harbour seals are non-migratory, found along the coasts of Atlantic Canada and Eastern Arctic including coastal Labrador (Gjertz et al 2001; Hammill et al 2010). Based on tagging studies, harbour seals have limited movements from summer and winter haulout sites once established (Lesage et al 2004; Hammill et al 2010), and are not likely to travel through the LSA.
	Harp seal	• Potentially present in the LSA. Following breeding and moulting periods in southern Labrador and northern Newfoundland ("the front") and the Gulf of St. Lawrence, harp seals disperse and migrate northward to Greenland and the high Arctic before returning to breeding grounds in the fall (DFO 2012). • Harp seals generally migrate along the Labrador coast to Greenland (DFO 2012; Hammill et al 2015).
	Grey seal	• Unlikely to occur in LSA. Grey seals are non-migratory, found in coastal habitats in the Gulf of St. Lawrence, Cabot Strait and Scotian Shelf (Harvey et al 2008, 2012). Seasonal movements of tagged grey seals showed that no individuals moved further eastward than the mouth of Placentia Bay, Newfoundland (Harvey et al 2008).
	Ringed seal	• Unlikely to occur in LSA. Sightings of ringed seals have been reported in northern Newfoundland; however, these are considered vagrants, as they are found in coastal waters of Labrador and the Arctic (DFO 2011).
	River otter	• Does not occur in LSA. • Widespread distribution; found in coastal and inland areas. Although they may forage in coastal marine waters, river otters remain close shore and do not cross open ocean. Individuals do not undertake large migratory movements (Naughton 2012).

As summarized in Table 12.7, existing and available biological information indicates that a limited number of the species that are known to currently be used by Indigenous groups have any potential to be present in the LSA and thus to be potentially affected by planned Project activities. While it is not possible to determine with absolute certainty whether an individual of any such species (in any life history stage) may be present in the LSA before moving to an area that is the subject of traditional harvesting activity (particularly for juvenile stages of some fish species with extensive dispersion), given

the highly mobile nature of species movement, the potential is extremely remote for any degree of connection between individuals within the LSA and those which would be harvested by Indigenous communities for traditional purposes. Moreover, as described for the preceding biophysical VCs (Chapters 8 to 10), the Project is not expected to result in significant adverse environmental effects upon marine fish, birds, or mammals, and the various mitigation measures identified throughout the effects assessment in this EIS will help avoid or reduce associated potential effects on these species.

There is no potential for the predicted biophysical effects of planned Project activities to have an adverse effect on the presence, abundance, distribution, or quality of these resources, and thus, their overall availability within traditional territories hundreds of kilometers away. Specifically, there will be no potential for any predicted effects on marine biota (see Chapters 8-10) to translate into a decrease in the overall nature, intensity, distribution (location or timing) or quality of these traditional activities by any Indigenous community.

The subsections that follow provide additional analysis related to two marine species that have been identified as being particularly important to various Indigenous communities, and for which the potential effects of the Project on these species formed a key part of their overall interest in the Project and its EIS (Chapter 3).

Atlantic Salmon

Several Indigenous groups considered in the EIS have placed special emphasis on Atlantic salmon (Section 3.3), an important and highly migratory species. Detailed information and biological analysis related to that species and its associated populations and movements was provided in Sections 6.1.8.6 and 8.4.4 of this EIS, and should be consulted for further details on the potential for each population to occur within the LSA.

Atlantic salmon occupy freshwater, estuarine and marine environments, occurring in approximately 2,500 rivers flowing into the North Atlantic Ocean. Despite extensive research on the freshwater portion of their life history, less is known about their life history once they leave their natal rivers and undertake migrations in the North Atlantic Ocean (COSEWIC 2010; Lefevre et al 2012, Windsor et al 2012). Anadromous Atlantic salmon typically leave their natal rivers during the spring as smolt where they spend from one to four years in the marine environment before returning to spawn as adults (Gardner 1976; COSEWIC 2010). The distribution and movement patterns of both post-smolt and adult salmon within the marine environment are highly complex and much information comes from studies related to commercial fisheries, research trawls, and tagging studies (Reddin and Friedland 1993; Reddin 2006).

In general, there are concentrations of both post-smolt and adult salmon in the Labrador Sea throughout the year where they feed and overwinter. Adult salmon, primarily multi-sea-winter (MSW) fish, are also found off west Greenland in the summer and fall. Prior to their spring spawning migration to their home rivers, adult salmon have been found congregating in two general offshore locations; approximately 480 km east of the Strait of Belle Isle and slightly east of the 200 m isobath (depth contour) along the eastern edge of the Grand Banks (Reddin and Friedland 1993). Age data, as well as river recaptures of salmon tagged off the Grand Banks indicate that salmon that congregate along the eastern Grand Banks are generally from more southern regions such as the Maritimes.

As described in Section 6.1.8.6, Atlantic salmon populations in Atlantic Canada are listed by COSEWIC from "not at risk" to "endangered". The 2010 COSEWIC Assessment and Status Report on Atlantic salmon outlines a total of 16 Atlantic salmon populations (COSEWIC 2010) (Table 12.8). Each of these populations has been delineated in terms of natal river destination within Designatable Units (DU) (see Section 6.1.8.6). The general criteria used by COSEWIC to recognize DUs, and therefore populations, are groups of individuals likely exhibiting unique adaptations that are largely components of the species' biodiversity (COSEWIC 2010). Summary information regarding the Atlantic salmon population within each DU is provided below in Table 12.8. This is based primarily on COSEWIC (2010) with updates since the COSEWIC assessment, where applicable. To date, there has not been any marine-based critical habitat established for populations of this species; the Inner Bay of Fundy population does have critical habitat identified within the freshwater environment (Canada Gazette 2010). Freshwater habitat is considered a general limitation to salmon production (COSEWIC 2010).

Table 12.8 Atlantic Salmon Populations / Designatable Units and their SARA and COSEWIC Status

Region	Population and Designatable Unit	*SARA*	COSEWIC
Nunavik and Labrador	Nunavik Population (DU1)	No Status	Data Deficient
	Labrador Population (DU2)	No Status	Not at Risk
Insular Newfoundland	Northeast Newfoundland Population (DU3)	No Status	Not at Risk
	South Newfoundland Population (DU4)	No Status	Threatened
	Southwest Newfoundland (Bay St. George Region) Population (DU5)	No Status	Not at Risk
	Northwest Newfoundland Population (DU6)	No Status	Not at Risk
Gulf of St. Lawrence	Quebec Eastern North Shore Population (DU7)	No Status	Special Concern
	Quebec Western North Shore (DU8)	No Status	Special Concern
	Anticosti Island (DU9)	No Status	Endangered
	Inner St. Lawrence (DU10)	No Status	Special Concern
	Lake Ontario Population (DU11)	No status	Extinct
	Gaspe-southern Gulf of St. Lawrence (DU12)	No Status	Special Concern
Eastern – Southern Nova Scotia and Outer Bay of Fundy	Eastern Cape Breton (DU13)	No Status	Endangered
	Nova Scotia Southern	No Status	Endangered

Region	Population and Designatable Unit	*SARA*	COSEWIC
	Upland (DU14)		
	Outer Bay of Fundy (DU16)	No Status	Endangered
Inner Bay of Fundy	Inner Bay of Fundy (DU15)	Endangered	Endangered

Table 12.9 below notes which of these identified Atlantic salmon populations are known to occur within the current areas occupied and used by each Indigenous group identified previously, or are most likely to be used by each of the Indigenous groups. It also provides a summary analysis of the potential for each population to spend time within the LSA, and thus to interact with the planned activities that will be associated with the Project.

Table 12.9 Atlantic Salmon Populations Used by Indigenous Groups and their Potential for Interaction with the Project

Indigenous Groups	Salmon Populations Known to be or Potentially Used	Potential for These Salmon Populations to Spend Time Within the LSA ***
Labrador: • Innu Nation • Nunatsiavut Government • NunatuKavut Community Council	• Atlantic salmon (Labrador Population)	• Labrador population likely absent or rare as northern populations are not likely to migrate south to the LSA.
Newfoundland: • Qalipu Mi'kmaq First Nation Band • Miawpukek First Nation	• Atlantic salmon (Northeast Newfoundland population, South Newfoundland population**, Southwest Newfoundland population, Northwest Newfoundland population)	• South Newfoundland population may migrate to southern slope of Grand Banks from Labrador Sea prior to spring spawning run to natal rivers.
New Brunswick: • Fort Folly First Nation • Eel Ground First Nation • Pabineau First Nation • Esgenoôpetitj First Nation • Buctouche First Nation • Indian Island First Nation • Eel River Bar First Nation • Metepnagiag Mi'kmaq First Nation • Elsipogtog First Nation • Kingsclear First Nation • Madawaska Maliseet First Nation • Oromocto First Nation • Saint Mary's First Nation • Tobique First Nation • Woodstock First Nation	• Atlantic salmon (Outer Bay of Fundy population*, Inner Bay of Fundy population*, Gaspe-Southern Gulf of St. Lawrence population)	• Outer Bay of Fundy population and Gaspe-Southern Gulf of St. Lawrence population may migrate to southern slope of Grand Banks from Labrador Sea prior to spring spawning run to natal rivers. • No interaction with the Inner Bay of Fundy population it remains within the southern Scotian Shelf and Gulf of Maine.

Indigenous Groups	Salmon Populations Known to be or Potentially Used	Potential for These Salmon Populations to Spend Time Within the LSA ***
• Peskotomuhkati Nation at Skutik (Passamaquoddy)		
Nova Scotia: • Acadia First Nation • Annapolis Valley First Nation • Bear River First Nation • Eskasoni First Nation • Glooscap First Nation • Membertou First Nation • Paqtnkek Mi'kmaw Nation • Pictou Landing First Nation • Potlotek First Nation • Wagmatcook First Nation • Waycobah First Nation • Millbrook First Nation • Sipekne'katik First Nation	• Atlantic salmon (Southern Upland population*, Eastern Cape Breton population*, Gaspe-Southern Gulf of St. Lawrence population)	• Nova Scotia populations may migrate to southern slope of Grand Banks from Labrador Sea prior to spring spawning run to natal rivers.
Prince Edward Island • Abegweit First Nation • Lennox Island First Nation	• Atlantic salmon (Gaspe-Southern Gulf of St. Lawrence population)	• Gaspe-Southern Gulf of St. Lawrence population may migrate to southern slope of Grand Banks from Labrador Sea prior to spring spawning run to natal rivers.
Quebec: • Micmas of Gesgapegiag • La Nation Micmac de Gespeg • Listuguj Mi'gmaq Government • Les Innus de Ekuanitshit • Montagnais de Nutashkuan	• Atlantic salmon (Anticosti Island population*, Quebec Eastern North Shore population, Quebec Western North Shore population, Inner St. Lawrence population, Gaspe-Southern Gulf of St. Lawrence population)	• Quebec populations, including the Anticosti Island population, may migrate to southern slope of Grand Banks from Labrador Sea prior to spring spawning run to natal rivers.
***** Salmon population identified as endangered by COSEWIC ** Salmon population identified as threatened by COSEWIC *** See Sections 6.1.8.6 and 8.4.4 for details		

As noted above, of the identified salmon populations, the Southern Newfoundland, Gulf of St. Lawrence origin, Southern Nova Scotia and Outer Bay of Fundy would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Banks in spring prior to completing their spring spawning migration back to natal rivers. Returning adults would also tend to move into Newfoundland coastal waters and then generally move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993). Most post-smolt from these regions would not likely overwinter in the Flemish Pass area (Reddin and Friedland 1993). In terms of initial post-smolt migration from their natal rivers to feeding areas in the Labrador Sea, they are likely to follow a generally coastal route along Newfoundland before moving offshore (Reddin and Friedland 1993; CSAS 2013).

Research to date provides an overview of general habitat use but also a description of suitable, preferred environmental conditions for salmon survival and growth. Changes in environmental conditions can spatially alter typical distributions and migration routes (Reddin and Shearer 1987) as well as marine survival (Reddin 2006). For example, catch data suggests that salmon modify movements at sea depending on sea surface temperature (SST). Reddin and Shearer (1987) found that low SST appeared not only capable of deflecting Atlantic salmon from recognized migratory paths, but modified movements such that fish would avoid cold water even though warmer water was beyond. This avoidance behaviour was shown to affect fish habitat use during years when cold water extended south by forcing salmon to move further south as well (Reddin and Friedland 1993).

While spring migration through and near the LSA is possible, salmon would be influenced by SST. Monthly SST values around the Project Area are a general indication that Atlantic salmon would not utilize the area outside the months July through to November and based on the SST temperatures recorded, overall use would likely be limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures near the Project Area during the spring were very low (0.0 – 1.0 fish per nautical mile of drift gillnet fished per hour) while efforts near the Project Area during winter produced no catches. No life stage of Atlantic salmon is dependent upon the Project Area and any utilization is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3^{o}C. However, it should be noted that surveys of the area are limited and regional variations in abundance have been reported (DFO, pers comm).

Given the available data, spring migration of adults within and near the Project Area is probable and therefore interaction between these populations and the Project would be considered possible, but of low likelihood. Moreover, given the relatively small area within which the planned Project activities and their potential environmental zones of influence would occur, and the short-term duration of these activities, there is a very low likelihood of interactions. As described for the various preceding biophysical VCs (Chapters 8 to 10), the Project is not predicted to result in significant adverse environmental effects upon any species of marine fish - including Atlantic salmon - particularly with the implementation of mitigation measures identified in this EIS. The Project will not have a significant effect on the presence, abundance, distribution, or quality of such resources in the area, and thus, their availability for resource use activities by Indigenous groups within their traditional harvesting areas. There will be no potential for such direct and/or indirect effects on Atlantic salmon to translate into a decrease in the overall nature, intensity, distribution or quality of these traditional activities by Indigenous communities.

Swordfish

A number of Indigenous groups in Eastern Canada also hold commercial-communal swordfish licences in NAFO Divisions that overlap with the LSA (Section 7.2). As noted in Chapter 3, these commercial fisheries activities formed the basis of a number of groups' stated interest in the Project and so potential effects on this species and these commercial fishing activities are given specific focus in the effects assessment for this VC. Although swordfish comprise a relatively limited amount of the overall commercial fisheries off Eastern Newfoundland (see Section 7.2.4.5) and elsewhere in Atlantic Canada, it is a relatively high value fishery overall. Like other large pelagic fisheries in the region, the fishery is focused primarily on the shelf break or in deeper waters to the south and east, and uses longline gear. Typically, swordfish longlines are set out for a day or less and then pulled back aboard the ship with its

catch; the preferred "soak" time is at night when fish are most active. Most fishing effort for this species has been concentrated in the Maritimes Region, but some harvesters do follow the fish eastwards to areas off southern and Eastern Newfoundland. DFO reported total landings of nearly 1,600 tonnes of swordfish worth $13 million in 2015, all by Maritimes-based enterprises (DFO 2017). Domestic swordfish harvesting levels have been relatively low in the Newfoundland and Labrador Region, as compared to landings from Georges Bank and the Scotian Shelf in the Maritimes Region. Typically, the movement from the Scotian Shelf to the Grand Banks occurs in mid- to late summer, depending on fishing conditions in the west, and some harvesters may continue fishing in the east until late fall.

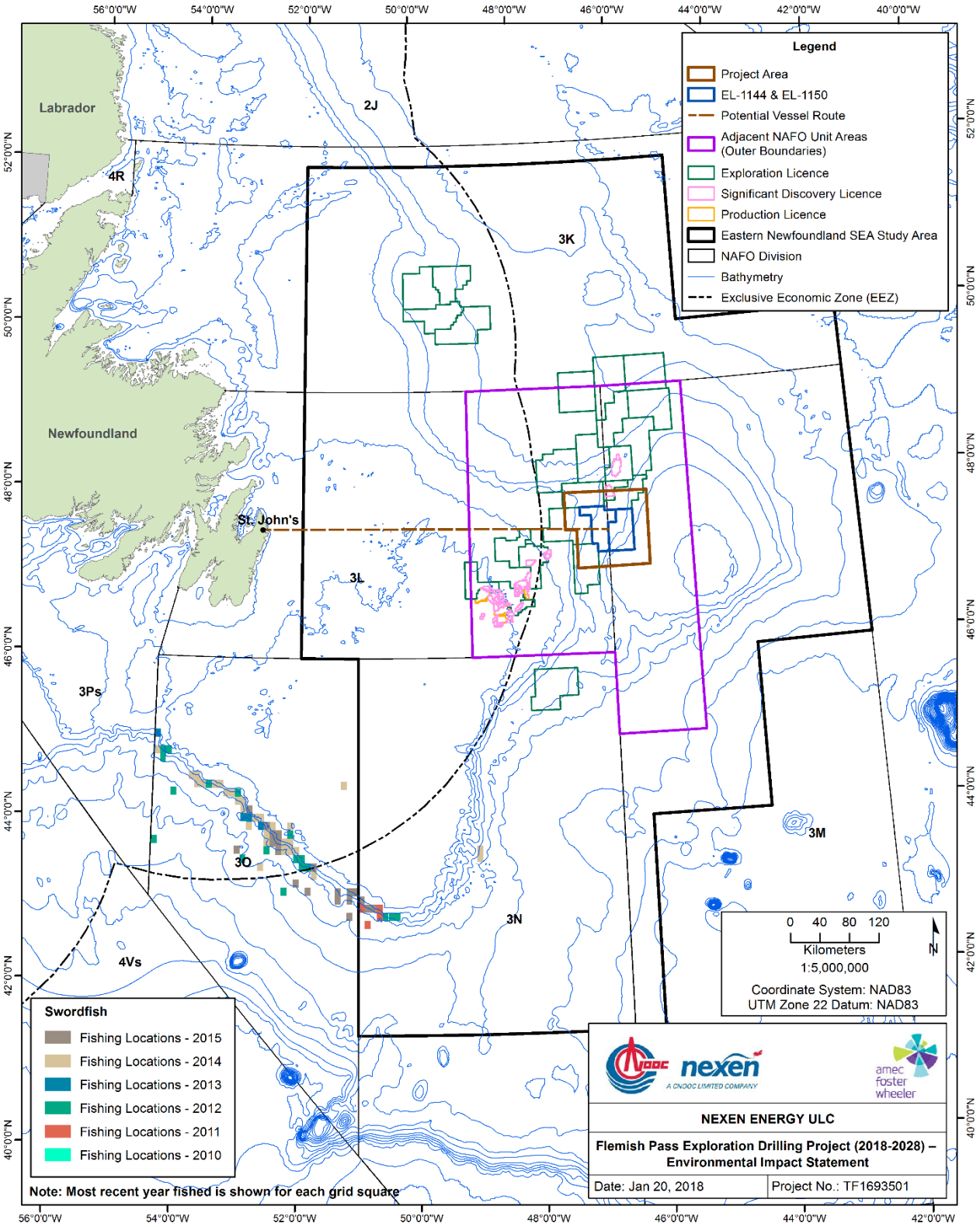
Figure 12.2 illustrates the known distribution of domestic (landed in Canada) commercial fishing activity for swordfish for the period 2010-2015, based on the DFO commercial fisheries geospatial datasets described and used in Section 7.2. As illustrated, there has been no recorded fishing activity for swordfish within or near the LSA over this period, with recorded catches occurring in NAFO Unit Areas well south of the Project Area. As such, there is limited potential for negative interactions between planned Project activities and fishing activity for swordfish by either Indigenous or non-Indigenous fishing enterprises.

In the event that commercial swordfish harvesting is undertaken within the LSA over the duration of this Project, potential effects would be similar to those described in Chapter 13 for commercial fisheries in general. Although Project components and activities, including the associated safety zones, will temporarily reduce access for fishing and other activities in certain areas, any such disturbances will be localized, short term, and reversible once Project activity ceases at a location. The potential for interference will be further mitigated through good communication and cooperation between industries, with fishing gear damage compensation initiatives being implemented as required. This, along with the localized and temporary nature of these disruptions, the limited amount of swordfish harvesting activity in the region overall, and the amount of alternative fishing areas available, means that the Project is not predicted to adversely affect the overall nature, location, timing, or value of these fisheries.

Swordfish have large-scale migration ranges that are ocean-wide in scale and occur primarily in a north-south pattern (Hoey et al 1989; Trenkel et al 2014). They are generally associated with thermal fronts, where there are large horizontal temperature gradients in the water column (Podesta et al 1993, Dewar et al 2011) that result in increased densities of swordfish prey items such as squid (Stilwell and Kohler 1985). The mixing of the cold Labrador Current and the North Atlantic Current creates these types of thermal fronts in some areas off Eastern Newfoundland, including the Newfoundland Seamounts and Flemish Cap (Carr et al 2001), both of which are outside the LSA.

Therefore, while the LSA is located within the overall areas used by swordfish, their overall distribution and migration patterns include most of the North Atlantic Basin (Dewar et al 2011; Trenkel et al 2014). Swordfish numbers and their overall ranges and migration patterns therefore make it unlikely that individuals or populations would interact with and be negatively affected by planned Project activities, and in particular, that this would translate into a decrease in the overall presence, abundance, distribution, or quality of this resource in any area, and thus, their overall availability for resource use activities by any Indigenous groups. No adverse effects on current or potential commercial-communal harvesting of this species by Indigenous communities are therefore expected.

Figure 12.2 Domestic Commercial Harvesting Locations: Swordfish (2010-2015)



12.3.3.3 Physical and Cultural Heritage (Including Structures, Sites or Things of Historical, Archaeological, Paleontological or Architectural Significance)

Heritage is an inclusive term that is associated with important aspects of human history and culture. Current perceptions of heritage tend to be quite broad and include various social, economic, political, environmental, scientific, natural and cultural dimensions (Canadian Environmental Assessment Agency 2015a). The cultural value of heritage or of any structure, site or thing originates from its: 1) Association with important aspects of human history or culture; 2) Historical, archaeological, paleontological or architectural significance; and 3) Association with a group's practices, traditions or customs, which are defined as follows:

> *Practice*: A way of doing something that is common, habitual or expected;
>
> *Tradition*: A custom, opinion or belief handed down orally or by practice; and
>
> *Custom*: A particular, established way of behaving (Canadian Environmental Assessment Agency 2015a).

The LSA is not known to contain resources of historical, archaeological, paleontological, or architectural significance, and given its location over 400 km offshore Eastern Newfoundland and 635 km from the closest Indigenous community, is not likely to contain such resources or materials that are relevant to and valued by Indigenous groups. As discussed above, based on the nature, location, extent and duration of planned Project activities and the associated emission and discharges, the Project will not interact with nor adversely affect physical and cultural sites, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance.

12.4 Environmental Effects Evaluation

This section summarizes the predicted residual effects of the Project on Indigenous peoples and presents a determination of significance for the environmental effects assessment for this VC.

12.4.1 Residual Environmental Effects Summary

Given the nature, location and timing of the various planned activities and associated environmental disturbances that will occur as a result of this Project, it is not expected to have any adverse effects on Indigenous peoples. As most planned Project-related activities will take place in an offshore marine environment, over 400 kilometers from land and over 635 km from any Indigenous community, and because any predicted environmental emissions and other disturbances are expected to be localized and short-term in nature (Chapters 8 to 10), they are unlikely to extend to or in any way affect the health (physical or social) and well-being or other socioeconomic conditions of any Indigenous peoples.

Although fishing enterprises associated with a number of Indigenous groups are known to undertake commercial fishing activities off Eastern Newfoundland, Nexen is not aware that any Indigenous groups hold or claim Aboriginal or Treaty rights within or near the LSA. Moreover, there are no documented food, social or ceremonial licences within or near the LSA nor do any groups otherwise undertake the current use of lands and resources for traditional purposes within or near this area. There are also no other known aspects of the physical and cultural heritage of these groups located in proximity to, or

which may otherwise be affected by, the Project. Nexen is aware that a number of Indigenous communities in Atlantic Canada hold treaty-based commercial communal swordfish licences for NAFO Divisions 3O, 3M and 3N. To date, no Indigenous community has indicated that they actively fish in the LSA, although it is recognized that this does not necessarily mean that they will not do so in the future. Given the nature of the Project, including its limited, localized and short-term environmental disturbances, and the associated small safety zone, it is not anticipated that there would be adverse effects to any such fishing activity, even if it did occur in the LSA over the course of the Project.

The environmental effects analysis also indicates there is limited potential for marine associated species that are known to be used by Indigenous groups to occur within the LSA prior to moving to any area of traditional use. The implementation of the mitigation measures outlined throughout this EIS will avoid or reduce direct or indirect potential effects on these resources. The Project will not have an adverse effect on the availability or quality of resources that are currently used for traditional purposes by Indigenous groups, especially in a manner or to a degree that would alter the overall nature, location or timing of current land and resource use activities for traditional purposes by one or more Indigenous groups, resulting in a detectable and sustained reduction in overall activity levels.

Table 12.10 summarizes the environmental effects assessment for Indigenous peoples. Given the nature, location and timing of the various Project activities and the lack of associated environmental interactions, the Project is not anticipated to have adverse effects on Indigenous peoples.

Table 12.10 Environmental Effects Assessment Summary: Indigenous Peoples

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *	
Summary of Existing Conditions and Environmental Context • There are no Indigenous communities or activities located within or near the LSA • Other past and on-going projects and activities in Eastern Canada have, to varying degrees, interacted with and affected Indigenous communities and activities, depending on their location, nature, and scale in relation to the communities, activities and other components and interests of individual groups. • The description of the socioeconomic characteristics of Indigenous groups provided in the EIS inherently reflects any such past and on-going activities and effects.	**Key Mitigation Measures** • The primary factor that is relevant to preventing or reducing potential environmental effects on this VC relates to the overall distances between planned Project components and activities and the various Indigenous peoples under consideration and their communities and known activities and interests. • Mitigation measures that are designed to avoid or reduce the potential effects of planned Project components and activities on the biophysical environment will also help to further avoid or reduce the potential for any associated effects on this VC . • Nexen will continue to be open and available to discuss the Project with any of the aforementioned Indigenous groups throughout the life of the Project (through established and/or informal engagement processes), which will include the provision of Project information and updates on on-going and planned activities, as well as discussion of any issues and potential means of addressing them. • Nexen will develop and implement an Indigenous Communities Fisheries Communication Plan.

Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• None anticipated	N	-	-	-	-	-	H
Drilling and Associated Marine Discharges (including fluids and cuttings)	• None anticipated	N	-	-	-	-	-	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
Vertical Seismic Profiling	• None anticipated	N	-	-	-	-	-	H
Well Testing	• None anticipated	N	-	-	-	-	-	H
Well Abandonment or Suspension	• None anticipated	N	-	-	-	-	-	H
Supply and Servicing	• None anticipated	N	-	-	-	-	-	H

Evaluation of Significance

Not Significant

- As there are no Indigenous peoples / communities or activities located within or near the LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project will not have adverse effects on this VC.
- The planned Project components and activities will therefore not have significant adverse environmental effect upon Indigenous peoples.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

12.4.2 Determination of Significance

As there are no Indigenous communities or activities located within or near the LSA, and because the environmental changes and effects of the Project will not otherwise extend to and affect lands and resources that are currently used by these groups for traditional purposes, the Project is not predicted to have adverse residual effects on this VC.

With the application of mitigation measures there will be no residual Project effects on Indigenous peoples, and therefore, no significant adverse environmental effects.

The potential effects of any accidental events that may be associated with the Project on Indigenous peoples are assessed and evaluated in Chapter 16 of this EIS

12.5 Environmental Monitoring and Follow-up

The various environmental monitoring initiatives outlined earlier in relation to the biophysical environment should also be indirectly applicable to this VC. Based on a review of existing, publicly available information and engagement conducted with Indigenous groups to date, and the associated results of the effects assessment reported in this chapter, no additional or specific monitoring or follow-up is considered necessary in relation to this VC, as no residual effects are anticipated.

Nexen will continue to communicate with Indigenous groups throughout the operational life of the Project, as required or requested, through established and/or additional engagement processes. The specific nature, frequency, subject matter and format of such future engagement will be determined in discussion with the Indigenous groups. Nexen will also continue to review these inputs and perspectives as the Project progresses, and will consider them in its Project-related planning and decision-making as applicable. These on-going engagement processes are intended to allow for continued discussion of Project related activities and issues as they may arise, as well as to collaboratively plan any revised management measures throughout the life of the Project.

Nexen will develop and implement an Indigenous Communities Fisheries Communication Plan (ICFC Plan). Indigenous communities will be invited to provide comments on the ICFC Plan. The ICFC Plan will be designed to:

- Identify communication objectives;
- Identify a list of participants and key contacts;
- Provide instructions for updating participants during the operational activities;
- Provide opportunities for feedback and further exchange of information; and
- Serve as a reference for expected communication during the unlikely event of a major incident such as a spill (see Chapter 16).

12.6 References

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13 FISHERIES AND OTHER OCEAN USES: ENVIRONMENTAL EFFECTS ASSESSMENT

Fisheries and other ocean uses have been identified and included as a VC for this EIS because of the economic and/or socio-cultural importance of these activities, their potential for interactions with planned Project-related components and activities, and as required by the EIS Guidelines issued for the Project by the Canadian Environmental Assessment Agency. The following sections consider and assess the potential for interactions between these anthropogenic components and activities and planned Project-related components and operations during the temporal scope of the Project.

As described in Sections 7.2 and 7.3 of this EIS, marine fisheries (commercial domestic, commercial foreign, aquaculture and recreational) conducted in or near the Eastern Newfoundland Grand Banks are important for their economic and cultural value. Some of these activities have the potential to occur in the same general locations and time periods, and thus could interact with, the various planned activities that will occur as part of this Project. In addition, because DFO and industry fisheries research surveys are conducted by “fishing” for species with trawls and/or fixed gear (Section 7.2.10), the potential for Project-related interactions with such research activities are expected to be the same as for commercial fisheries. Although any resulting effects on fishing success could result from biophysical effects on commercial fish species or their habitats, these are assessed in Chapter 8, and not addressed in detail again here, particularly since the Project is not predicted to result in significant adverse environmental effects on marine fish and fish habitat (including commercially important species), and thus, on the overall presence, distribution, and quality of these resources for associated harvesting activities.

As described in Section 7.4 and in Chapter 12, there is no known Indigenous food, social, or ceremonial fishing within or near the Project Area, nor are there any known heritage sites. Fishing by Indigenous groups off Eastern Newfoundland, and potentially within the Project Area, is undertaken through licenses issued by DFO, and are thus considered within the domestic commercial fisheries component of this VC.

Other human components and activities occur within the marine environment offshore Eastern Newfoundland and are also important for their economic and/or cultural value. As described in Section 7.3, those other components and activities that do or may occur within or near the Project Area and are thus considered as components of this VC include general marine shipping, other oil and gas related activities (such as seismic exploration, production platforms and associated marine traffic), military operations (such as surveillance, monitoring, training, rescue), other submarine infrastructure (such as communication cables) and the possible presence of UXO (EIS Guidelines, Part II, Section 6.1.9.2).

This chapter assesses and evaluates the potential effects of planned Project components and activities on this VC, in accordance with the specifications of the EIS Guidelines, whereas those which may result from possible accidental events are described in Chapter 16.

13.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for this VC and the various criteria that have been established to evaluate the significance of the predicted effects on this VC.

13.1.1 Spatial Boundaries

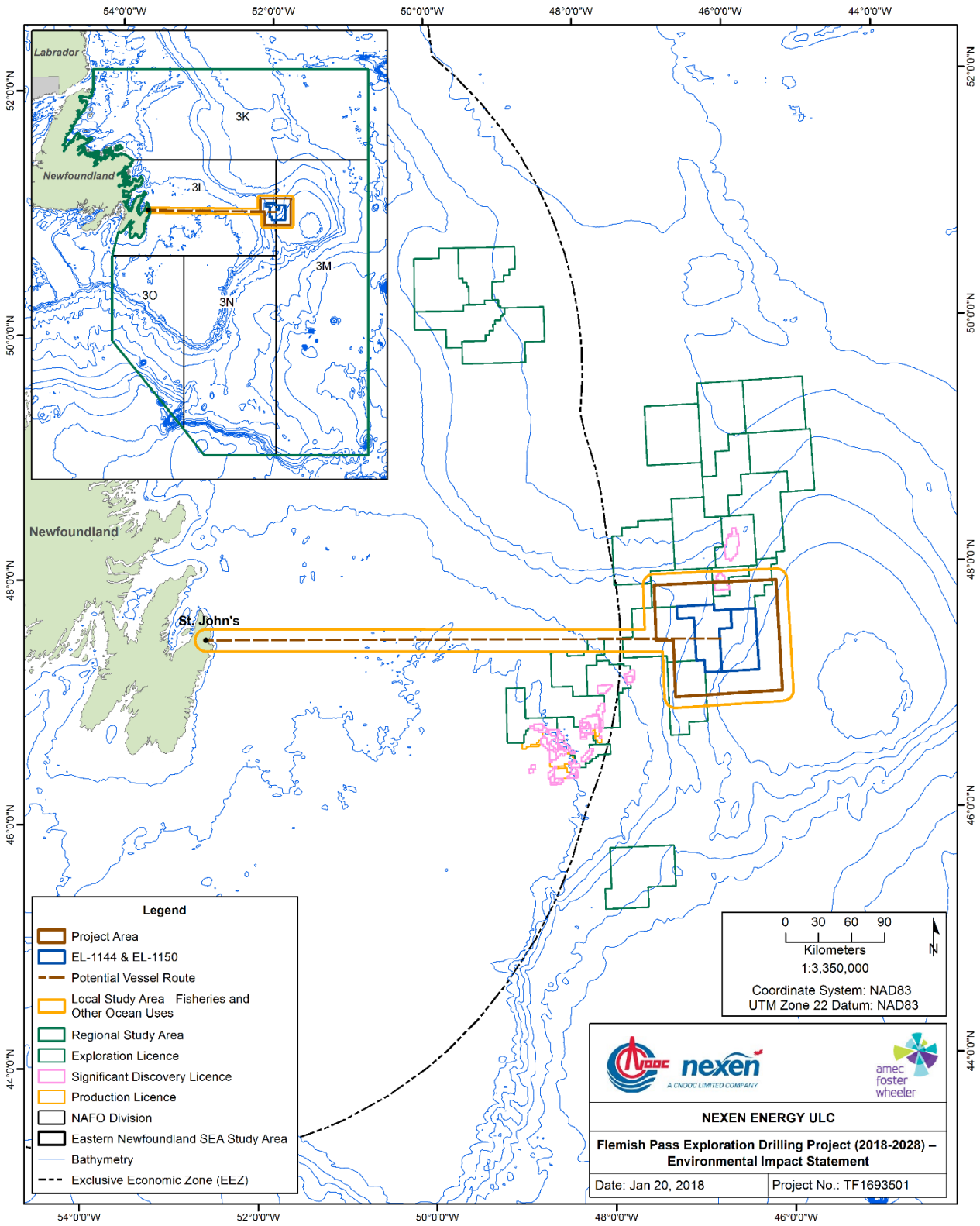
The spatial boundaries (Figure 13.1) reflect the areas within which planned Project components and activities may interact with the various human activities that are considered as part of this VC, as well as the administrative areas (and associated datasets) that are used in this document (Sections 7.2.1 and 7.2.2) to characterize the existing environment within the region.

Project Area: This area encompasses the overall geographic area offshore Eastern Newfoundland within which all planned Project-related exploration activities will take place. This includes ELs 1144 and 1150, within which drilling will occur, as well as a surrounding 20 km buffer area to account for any ancillary activities (such as walk away VSP surveys) that may extend outside the boundaries of the ELs themselves. While the Project Area is defined as an overall polygon that encompasses all such activities over the course of the Project, the various activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's components and activities, and therefore, encompasses the overall geographic area over which all planned Project-related environmental interactions (including any emissions and other disturbances) are predicted to occur. Because most of the potential effects of the Project on fisheries and other ocean uses would relate to the potential for direct disturbance and interference with established activities due to the presence of Project-related components and activities, these are likely to occur primarily if not exclusively within the Project Area itself. As described for the preceding marine fish and fish habitat VC (Chapter 8), a 10 km area around the Project Area has also been defined as the LSA for that VC, to account for Project activities that could conceivably occur on the edges of the Project Area boundary and associated interactions with other marine activities and their associated resources beyond the Project Area boundary. For this VC, the LSA is therefore (conservatively) defined as the offshore Project Area and the associated vessel and aircraft traffic route, and an appropriately 10 km area around these.

Regional Study Area (RSA): In addition to these Project- and disturbance-related factors, the environmental effects assessment for this VC also recognizes and considers the spatial distribution and overall geographic extent of fishing and other human activities within and adjacent to the Project Area / LSA and in the broader surrounding region. The RSA for this VC generally captures the marine waters offshore Eastern Newfoundland, namely NAFO Divisions 3K, 3L, 3M, 3N and 3O.

Figure 13.1 Fisheries and Other Ocean Uses: Environmental Assessment Study Areas



13.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the potential duration of Project-related activities in the Project Area (2018-2028, see Section 2.7), as well as the likely timing of any resulting environmental effects. Because some activities or the presence of some equipment could occur year-round, fishing and other marine activities during all months of the year are considered here. Section 7.2.6.4 provides details of these activities and their timing of occurrence within these areas, and indicates that while commercial fishing and other ocean uses occur year-round within the Project Area, LSA and RSA, the most active period overall is typically during the summer months.

13.1.3 Environmental Effect Significance Definitions

Potential effects from planned activities and components on the fisheries and other ocean uses VC are evaluated within the context of the identified spatial and temporal boundaries described above. Significant environmental effects are considered to be those that cause an adverse change in a VC that would alter its status or integrity beyond an acceptable level. For the purposes of this VC, significant environmental effects are defined as those that would cause one or more of the following:

- *A negative change in the overall nature, intensity, location or timing of current marine-based commercial activities, resulting in a detectable decrease in overall activity levels and/or the economic returns generated from fisheries or other commercial activities within the RSA over multiple years.*

- *A negative change in the overall nature, intensity, location or timing of current marine-based research activities in the RSA, resulting in a detectable decrease in quality and utility of the information generated by such surveys and in any management decisions which are made on the basis of this information.*

- *A negative change in the overall nature, intensity, location or timing of current marine-based recreational activities, resulting in a detectable decrease in overall activity levels and/or the enjoyment of any such activities within the RSA for a community or region over multiple years.*

13.2 Potential Environmental Changes, Effects and Associated Parameters

The EIS Guidelines identify various issues and potential effects on fisheries and other ocean uses which should be considered for assessment in this EIS. These are listed in detail in the Table of Concordance included at the beginning of the EIS.

Questions and comments related to this VC were also noted during Nexen's Project-related engagement with government departments and agencies, stakeholder organizations, and Indigenous groups. This included questions and concerns regarding the locations and timing of key fishing activities in relation to the Project Area, and the potential for direct interference with fisheries and other marine activities due to the presence of the MODU(s) and associated safety zones, as well as direct effects on fish resources due to Project-related noise and other emissions (see Chapter 3 for further details).

Other marine components of the human environment to be considered in the EIS Guidelines include (Part II, Section 6.3.8.4) "socio-economic conditions, physical and cultural heritage and any structure,

site or thing that is of historical, archaeological, paleontological, or architectural value", and including marine tourism, hunting and recreational activities, other shipping, and physical and cultural heritage (e.g. shipwrecks). Based on a consideration of the location, timing and types of activities associated with the Project, certain of these marine components do not have a potential to interact with the Project, or else are reasonably considered as part of another component of this VC. These components, and the rationale for excluding them or grouping them with another component, are outlined below.

Other Offshore Exploration Drilling and Production Activities: These include other exploration drilling sites, production facilities and associated in-place infrastructure off the east coast of Newfoundland and Labrador. They are excluded from the effects assessment because of the distance between the Project Area and the various existing production projects off Eastern Newfoundland (see Section 7.3.2) and because no other operator may undertake exploration drilling within the Nexen-held ELs 1144 and 1150 over the terms of these licences. Moreover, any such drilling activities off Eastern Newfoundland in general will be protected by designated safety zones, which will be charted by all Project-related vessels and will be avoided during supply vessel transits.

Aquaculture: Aquaculture operations (as described in Section 7.2.12), while important to the regional economy, are not considered further since the closest such operations are more than 400 km from the Project Area and therefore pose no potential for interaction with planned Project activities within the LSA. Existing aquaculture operations are also well outside anticipated vessel traffic routes, with the single operation on the eastern Avalon Peninsula being nearly 40 km south of, for example, a straight-line route from the support vessel route between the Project Area and the Port of St. John's.

Recreational Fisheries, Hunting and Marine Tourism: The Project Area's distance from shore is also the reason for excluding recreational and food fisheries, hunting (Section 7.3.9) and tourism as separate components of this VC. None of these activities are known to occur at great distances from shore. For any recreational (fisheries or hunting) or tourism vessels sharing Project vessel traffic routes, the potential for interactions and effects, and therefore the mitigations required, are the same as for other vessel traffic, as assessed below.

Other Cultural Heritage Sites. As described in Section 7.3.8, there are no known cultural heritage sites within the Project Area, and no shore-based or coastal sites have a potential for interaction with planned Project Activities, which will occur entirely within existing and established industrial port facilities.

The following assessment therefore focuses on potential interactions with, and potential effects on, domestic and foreign commercial fishing (including fisheries science surveys), other marine vessel traffic (including military operations), other oil and gas exploration (including seismic) activities that occur beyond designated safety zones, and existing subsea infrastructure (cables) and other components (UXO, including Legacy Sites, shipwrecks). As noted, any potential effects upon traditional activities by Indigenous peoples are assessed in Chapter 12, and accidental events and malfunctions, and their potential effects on all VC components are assessed separately in Chapter 16.

Based on these identified components, the following potential interactions have been identified as important and relevant to the fisheries and other ocean uses VC, based on previous EAs conducted for similar projects and activities offshore Newfoundland and Labrador, including the Eastern Newfoundland SEA (Amec 2014), and on issues raised during government, stakeholder, and Indigenous engagement activities undertaken for this EIS (Chapter 3).

13.2.1 Fisheries

- Potential temporary loss of access to established fishing grounds due to Project activities and components, and a resulting decrease in value (economic or otherwise) of these fishing activities.

- The possibility of damage to fishing gear, vessels, equipment, or other components due to interactions between Project vessels, equipment, emissions or discharges and fishing activities.

- The possibility of interference with scheduled government / industry fisheries research activities, which might also affect research results and associated management decisions.

- The possibility of price implications resulting from market or consumer perception of a reduced quality of fish products (eg, taint).

- The possibility of indirect effects on fisheries due to changes in the abundance, distribution or availability of fish species on established fishing grounds.

13.2.2 Other Ocean Uses

- Potential interference or conflict with other offshore petroleum exploration activities (seismic and other surveys, supply and service vessels).

- Potential interference with other shipping in the area (commercial, pleasure craft, military operations).

- Potential direct physical conflicts with existing submarine infrastructure (subsea cables) or other human-made components (UXO, including Legacy Sites)

These interactions and associated environmental changes that may lead to possible environmental effects on this VC are summarized in Tables 13.1 and 13.2, along with the identification of a number of associated parameters through which these Project-related changes and effects may be reflected.

Table 13.1 Potential Project-Related Environmental Changes and Resulting Effects: Fisheries

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• Temporary loss of access to localized marine areas because of the presence of drill units and other exploration equipment and activities, including safety zones • Temporary interference/disruption of fishing or actual or de facto loss of access to excluded fishing grounds necessitating altered vessel routes or movement to alternative grounds.	*Direct interference with fishing or exclusion from established fishing grounds*	• Marine areas currently used and availability of alternative grounds for fishing • Time and costs associated with carrying out fishing activities • Economic returns from fishing

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• This might affect the efficiency of harvesting resulting in lower catches and/or revenues, lost time and additional operating costs.		
• Project activities may result in damage to fishing gear or vessels if they come into direct contact with offshore drill units or other equipment, or if Project components tangle or foul fishing gear. • Possible associated economic effects on fishers might result from lost fishing efficiency, lost catch, and associated repair or replacement costs.	*Damage to fishing gear or vessels*	• Amount and value of lost or damaged gear • The number of damage or loss claims • Economic returns from fishing
• A potential change in the abundance, distribution and availability of commercial fish species on established grounds because of Project activities (e.g. sound and other emissions) may result in diminished fishing success (e.g. lower catches and revenues, lost time, additional operating costs). • Any change in the (real or perceived) quality of marine resources has a potential to result in lower market demand and/or commercial prices.	*Decreases in the abundance, distribution and actual or perceived quality of fisheries resources*[5]	• Availability of targeted marine resources • Changes in prices or market perception • Economic returns from fishing

Table 13.2 Potential Project-Related Environmental Changes and Resulting Effects: Other Ocean Uses

Potential Environmental Changes	Potential Environmental Effects	Associated Parameters
• Possible damage to subsea cables or UXO interaction	*Direct contact with and damage to in situ component*	• Presence and condition of existing marine components
• Temporary loss of access to localized marine areas because of the presence of drill units and other exploration equipment and activities, including safety zones • Associated interference/disruption of other shipping (including other petroleum exploration) diverting around safety zone or active work areas outside the safety zone • This might affect the nature and efficiency of these other activities	*Interference with other marine activities*	• Availability of alternative routes and areas • Time and expenses related to diversion • Change in marine safety

[5] As noted above, biophysical effects on fish and fish habitat resulting from Project-related activities are considered and assessed as not significant in Section 8.5

Potential Environmental Changes	Potential Environmental Effects	Associated Parameters
• Possible marine traffic congestion • Avoidance of abandoned wells by future marine activities		

The environmental effects assessment for this VC focuses primarily on those planned Project components and activities that have the potential to interact with the fisheries and other ocean uses VC. An overview of the potential for each of the Project's planned components and activities to result in one or more of the above noted potential environmental effects on this VC is presented in Tables 13.3 and 13.4.

Table 13.3 Potential Project-VC Interactions and Associated Effects: Fisheries

Planned Project Component / Activity	Potential Environmental Effects		
	Direct interference with fishing activity or exclusion from established fishing grounds	Damage to fishing gear or vessels	Decreases in the abundance, distribution and actual or perceived quality of fisheries resources
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●	●
Drilling and Associated Marine Discharges (including fluids and cuttings)		●	●
Vertical Seismic Profiling	●	●	●
Well Testing			●
Well Abandonment or Suspension	●	●	
Supply and Servicing	●	●	●

Table 13.4 Potential Project-VC Interactions and Associated Effects: Other Ocean Uses

Planned Project Component / Activity	Potential Environmental Effects	
	Direct contact with and damage to in situ component	Interference with other marine activities
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●
Drilling and Associated Marine Discharges (including fluids and cuttings)	●	
Vertical Seismic Profiling		●
Well Testing		
Well Abandonment or Suspension		●
Supply and Servicing		●

13.3 Environmental Effects Assessment and Mitigation

This section identifies the approaches and methods used in the effects assessment for the fisheries and other ocean uses VC, describes key mitigations that will be implemented to prevent or reduce any potential adverse effects, and provides an assessment and evaluation of the potential (residual) effects of the Project (planned components and activities) on the fisheries and other ocean uses VC with the identified mitigations in place.

13.3.1 Approach and Methods

The assessment that follows focuses on the potential interactions identified above. Potential Project-related environmental changes and resulting effects are assessed by considering the available data and other information about the type and distribution of fisheries and other activities in the Project Area / LSA and the RSA, as presented in Section 7.2 of this EIS, as well as on relevant documentation and past experience with similar projects and activities in this area. Each planned Project component is considered in terms of its potential to cause environmental changes that might affect the VC, and in light of the nature and likely effectiveness of the mitigation measures proposed. Any potential Project-related residual effects are then identified and evaluated for significance. As noted above, the assessment of potential biophysical effects on fish species, prey and fish habitat are treated separately in Chapter 8, and these are found to be not significant.

13.3.2 Summary of Key Mitigation

Past petroleum exploration operations in the Atlantic Canadian offshore have led to the establishment of several mechanisms and practices that have proven to be valuable and effective in mitigating potential adverse effects. These will also be employed by Nexen during all relevant phases of the

planned exploration activities that comprise this Project, and include the following (see also Section 8.3.2):

13.3.2.1 Fisheries

a) There will be continuing communications and regular information exchanges (FFAW-Unifor, DFO Science Branch, One Ocean, other stakeholders) about current fishing plans and current Project activities. It is also expected that regular updates will be submitted to the C-NLOPB before each year's operations commence, which will report on recent information exchanges, updates, any changes in the fisheries (including any new fisheries) and current-year Project plans and schedules and associated mitigations.

b) At-sea monitoring of, and direct communications with, vessels (radar, AIS, direct at-sea radio communications), and use of AIS by all sea-going Project vessels.

c) The establishment and communication of identified safety zones (with ship hailing protocols and other measures) to protect the safety of personnel and equipment and eliminate the risk of fishing gear or vessel damage near the MODU.

d) Strict adherence to and implementation of all relevant regulatory guidelines and best practices for the selection and use of materials, and for managing marine discharges from Project-related MODUs and vessels.

e) The establishment, implementation and communication of a *Fishing Gear Damage or Loss Compensation Program*, in accordance with applicable C-NLOPB requirements, to address any unplanned interactions between Project components and commercial fishing equipment.

f) The use of a Fisheries Liaison Officer (FLO) on board survey vessels and during MODU movements as appropriate; the requirement for this to be determined in discussion with regulatory authorities and the FFAW-Unifor in accordance with the *Risk Management Matrix Guidelines* developed by One Ocean.

g) The designation and use of a Single Point of Contact (SPOC) during marine operations to facilitate Project-fishing industry communications in real time, and to respond to gear / vessel damage claims.

h) Notices to Shipping / Notices to Mariners for planned Project activities (including activity, safety zones, installation locations and timing), and information about contacting Project representatives (e.g. the SPOC).

i) The communication of the locations of any wellheads left in place to harvesters and appropriate authorities for inclusion on nautical charts for the information of commercial fishers and other mariners as applicable.

13.3.2.2 Other Ocean Uses

a) Notices to Shipping / Notices to Mariners for planned Project activities (including activity, safety zones, installation locations and timing).

b) Monitoring of and direct communications with other vessels (radar, AIS, direct at-sea radio communications), including use of AIS by all sea-going Project vessels.

c) Adherence to the *Canada Shipping Act, 2001* (and *Collision Regulations*) and other applicable legislation and regulations.

d) Awareness of and adherence to relevant sections of Section F (National Defense – Military Notices) of Notices to Mariners Annual Edition (2017) with respect to possible military activities.

e) Identifying a specific point of contact for MARLANT queries and concerns, and to ensure engagement of CPF 84, through Director General Naval Strategic Readiness (DGNSR), to ensure de-confliction with possible Allied submarine activities.

f) Identification and avoidance of other offshore petroleum installations and their safety zones.

g) Avoiding existing subsea cables within the ELs when deciding on drilling locations.

h) Surveying drill locations for the presence of UXO and shipwrecks before equipment is placed and drilling begins; treatment of suspected UXO according to Notices to Mariners Annual Edition (2017) Section 37, and reporting to DND.

i) The communication of the locations of any wellheads left in place to appropriate authorities for inclusion on nautical charts for the information of marine operators.

These mitigation measures are considered in an integrated manner in the environmental effects analysis that follows. Measures to avoid or reduce potential adverse environmental effects on marine fish and fish habitat (Section 8.3.2) are also relevant to the fisheries component of this VC.

13.3.3 Presence and Operation of MODUs

The presence and operation of one or more MODU(s) within the Project Area has the potential to interact with marine fisheries and other marine users by making limited areas temporarily unavailable for fishing or transit while equipment is present and operations are active. The MODU (drill ship or semi-submersible) work area (including any anchors) will be identified and circumscribed by a mandatory safety zone which will exclude fishing and/or non-Project marine activities and transits in the local area in order to protect against accidents and help protect human safety.

Details about the exact location, size and timing of the safety zones, as well as hailing requirements and any other precautions required will be communicated directly to the fishing industry and other marine users, and will be the subject of Notices to Shipping / Notices to Mariners . Information required to contact the relevant MODU personnel will also be provided. All marine assets will also be identified at sea by way of AIS transponders and appropriate safety lighting. Each MODU will also have a

dedicated stand-by vessel present at all times for safety and response to any situations requiring assistance. The only anticipated Project-related marine activities that will occur outside of this area once established will be possible “walk away” VSP surveys and supply and service vessel transits (both of which are discussed further below). The establishment and communication of the mandatory safety zones around installations will effectively eliminate the potential for fishing gear or marine vessel damage within these designated locations.

Safety zones are typically 500 m in radius, but no more than 1,000 m in radius, and would temporarily prohibit access to the designated area. Because more than one MODU might be operating at the same time during the Project scope, this would increase the total size of excluded area within the Project Area by a proportional amount. It is anticipated that a safety zone would be in place for the duration of each well drilled. This exclusion of access to these areas has the potential to result in a temporary decrease in fishing efficiency or increased costs to fishing and other vessel transits in the immediate area as harvesters redirect effort to other grounds and/or vessels navigate around the zone.

As noted previously, while drilling activity by a single MODU at any one time is the most likely scenario, there could at times be multiple (likely two) MODUs operating in the Project Area simultaneously. Even assuming maximum-case 1,000 m-radius safety zones and up to three in effect at the same time, the area excluded would be less than 0.2 percent of the Project Area / LSA and less than 0.0008 percent of the RSA. Further, as the DFO locational data indicate (see Section 7.2) the ELs and Project Area have recorded little domestic commercial fishing activity in recent years compared to other parts of the LSA, the RSA and the Grand Banks generally, so that an even lower proportion of actual fish harvests or incomes might have the potential to be affected. Further, most recorded Project Area harvesting in recent years (groundfish and Northern shrimp) has been conducted by mobile trawlers, which can maneuver fairly easily around small closed areas such as these. The situation is similar for the international fisheries (also mainly mobile) in the area. Therefore, as Section 7.2.4 indicates, the Project Area, and the ELs in particular, overlap with relatively low-intensity international commercial fishing areas. With the current moratorium on shrimp fishing in the general area for both foreign and domestic harvesters, current use of the Project Area is expected to be even less than historically recorded, although it is possible that this fishery could be reinstated within the temporal scope of this EIS (Section 7.2.8).

For fisheries science research surveys conducted by DFO, Nexen will communicate with DFO Science Branch about any plans for such RV surveys in or near planned drilling locations and will coordinate activities to the extent possible not to interfere with or influence them. For the fixed gear Industry-DFO Collaborative Post-Season Snow Crab Trap Survey conducted with the FFAW-Unifor, the closest survey station (Section 7.2.10) is located more than 40 km from the nearest point on the Project Area boundary and nearly 70 km from the closest EL boundary, so it is expected that there would be no potential for that survey to interact with the planned drilling activities.

In all cases, the effects of the safety zone exclusions and activities occurring within them will be highly localized (a few square kilometers) and temporary (up to 160 days) so that detectable effects on overall fishing activity (intensity or successes) will not likely be detectable and will be within the range of natural variability, without risk to the overall viability of or economic returns from any fishery. The same is the case for other marine vessels transiting through the areas, where slight route deflections might be required to avoid passing through or too near a safety zone, but without economic consequences.

If a chosen drill site location were to conflict with existing infrastructure or other human-made components (particularly a UXO, a shipwreck or sub-sea communication cables), there is a potential for damaging the infrastructure or encountering a safety risk. As described in Section 7.3.6, three active communications cables are known to pass through the ELs. Although there are no documented shipwrecks within the Project Area and no known UXO locations, it is possible that one or more are present. Any such issues will be prevented through a process of seabed investigation before any equipment is installed or drilling begins. If any incompatible structures are found, they will be avoided. In the case of a suspected UXO being identified, the response will follow Notices to Mariners Annual Edition (2017) Section 37, with the location immediately reported to DND.

No adverse effects on fishing or other ocean uses in the area are expected due to the presence of lights on installations or vessels or to air emissions originating from them, particularly considering the application of the safety exclusion zones. The potential effects of sound emissions from drill sites on fish and fish behaviour are also discussed and assessed in Section 8.3, where these are also found to be not significant. As that section concludes, while there might be some localized movement of finfish away from the immediate area during certain activities, this is not expected to extend far beyond the safety zone, where commercial fishing will be excluded during Project activities. Given the comparatively low levels of past fishing activity within the ELs, no effect on fishing success is expected from any such environmental disturbances.

Based on this, and with the implementation of the applicable mitigation measures as summarized in Section 13.3.2, the overall magnitude of the effect of the presence and operation of the MODU and associated drilling activities on fisheries and other ocean uses is anticipated to be low. The slight, temporary decrease in access to potential fishing grounds will be localized, temporary, and entirely reversible. The localized and temporary nature of these disturbances and exclusion zones at any one location and time during the Project considerably reduces the potential for adverse effects on fisheries or other ocean uses.

13.3.4 Drilling and Associated Marine Discharges

The presence and operation of MODUs have a potential to affect the abundance, location and/or quality of commercial fisheries resources in localized areas as a result of fish interactions with emissions, which may in turn affect their availability to fish harvesters or the quality or saleability of fish products. These potential marine discharges include drilling fluids and wastes (e.g. fluids and cuttings), deck discharges (e.g. oily water), and organic waste. There is no expected interaction with other ocean uses considered within this VC.

The potential biophysical effects of these emissions on marine fish and fish habitat (including species targeted by commercial fisheries and considered in fisheries research surveys) are described and assessed in Section 8.3. This VC concludes that the Project is not expected to result in significant adverse environmental effects on marine biota considering the types of materials selected for use and the handling and containment and/or treatment of those materials. In particular, all discharges will be in full compliance – in terms of the product used, discharge types and limits and other mitigations – with standards and other requirements. These include measures that are regularly implemented for such programs in the Canada-NL offshore area to protect marine biota and their habitat as conditions of approvals. Given these mitigations and the very localized nature and extent of the planned activities, there is also no expectation of a change in market perceptions of the quality of fish harvested near

drilling locations, and therefore no expectation of any effect on price paid to harvesters as a result. To date there have been hundreds of wells (exploration, delineation, production) drilled in the Canada-NL Offshore Area, with no documented effects on marketability resulting from these operations.

Any residual effects on the fisheries and other ocean uses VC because of drilling associated discharges (if they did occur) are therefore predicted to be negligible in magnitude, localized and within the Project Area, short to medium-term in duration, occurring sporadically and reversible.

13.3.5 Vertical Seismic Profiling

Project-related VSP surveys are expected to be conducted in conjunction with wellsite drilling. Although very short in duration compared to other surveys using seismic (geophysical) technology or to the drilling activities themselves, VSPs have some potential to interact with fisheries through vessel interference, gear damage, and a change in local abundance and location of fish species resulting from the sound energy released. Interference with other ocean uses is also possible due to the temporary increase in vessel activity if a separate VSP source ship is used during a VSP survey.

As described in Section 2.5, these surveys are typically undertaken following completion of drilling to correlate with other data and help assess a well's potential productivity. They are usually undertaken by placing geophone receivers within the borehole at different depths, while a small sound source array is suspended in the water from the MODU. A variation of this procedure (a "walk-away" VSP survey) involves placing the sound source on a separate vessel which then moves away while intermittently activating the source. VSP surveys are typically short-term activities (usually 1-2 days duration), with seismic source activation often limited to a portion of that time.

Compared with the typical 2D and 3D marine seismic surveys which are common in the Canada-NL Offshore Areas, sound source arrays used for VSP surveys are small in cubic volume, whether towed in a walk-away, or suspended from the MODU. As discussed in detail in Section 8.3.5 of this EIS and in all recent marine seismic survey assessments for the Canada-NL Offshore Area - which are based on extensive scientific literature reviews - biophysical effects of seismic arrays on fish, fish larvae and other marine biota are not significant, and any behavioural effects on commercial species (e.g. scaring away from fishing areas) are limited and transient in nature. This would be particularly the case for sound from VSP surveys in the Project Area, given their infrequency during the Project, the area's distance from more concentrated fishing activities, the smaller array volume used, their short duration (Section 2.5.2), and the relatively short distances covered by walk-away surveys. In any case, advance communications will be maintained with fishing interests, fisheries scientists and military operations to further identify and mitigate any potential for interference with any activities that might be close by. As with other Project-related activities, Notices to Shipping will be filed for each survey.

Since walk-away VSPs do not tow hydrophone streamers, the particular risk of potential physical conflict with fishing gear is absent. The source array is only a few metres long and is towed at a shallow depth, immediately behind the ship, so that the remaining risk to gear is virtually no greater than that posed by other support vessels transiting within the Project Area (as discussed below). The increase in vessel activities owing to the ship used for a walk-away VSP is also minimal owing to the infrequency of such surveys and their restricted range. If another petroleum exploration survey (a geophysical survey) is present in the same area or nearby, time-sharing or other mutually-agreed interference mitigations will be implemented if required, according to standard industry practices.

In consideration of the limited temporal and geographical scope of VSP surveys, and the implementation of communication and other mitigation measures, any residual adverse environmental effects of Project-related VSP surveys on fisheries and other marine activities are predicted to be negligible in magnitude, localized, short-term in duration, occurring sporadically and reversible.

13.3.6 Well Testing

Well fluids may be sent through the wellbore and to the MODU for hydrocarbon flow testing, but these fluids are contained within a closed casing and do not enter or otherwise interact with the marine environment. Similarly, flaring (the in-air burning of hydrocarbon and some produced water that may be released during the testing process) is not anticipated to have an interaction with fishing activity or other marine activities since it would take place above the water and the MODU and within the Safety Zone.

In consideration of the limited temporal and geographical scope of these activities any residual adverse environmental effects on fisheries and other marine activities are predicted to be negligible in magnitude, localized, short-term in duration, occurring sporadically (if at all) and reversible.

13.3.7 Well Abandonment or Suspension

After the drilling and testing at each site has been completed, the wells will be abandoned or suspended following requirements under the Newfoundland Offshore Petroleum Drilling and Production Regulations and in accordance with Nexen's own procedures and industry best practices. As described in Section 2.5.2.5, in some instances wellheads will be removed by cutting below the sea floor which will leave nothing protruding. For some wells, approval may be sought to leave the wellhead in place, in which case these will be communicated to the relevant authorizes for inclusion on the applicable nautical charts. All wells will be monitored and inspected in accordance with applicable regulatory requirements.

Where planned, wellhead removal will be undertaken using conventional methods and is expected to cause minimal environmental disturbance. These activities will be localized and short-term and will take place within the safety zone, and, as a result, no additional interactions with fisheries and other marine activities are expected.

The drilling locations where the wellheads are removed will be opened to normal fishing and shipping activity as soon as the safety zone is rescinded. In deeper areas of the Flemish Pass, the limited amount of the wellhead infrastructure that will remain on the sea floor can pose a risk to bottom-tending mobile fishing gear, which could result in damage and lost time or catch. These gears include stern otter trawls and (in the past) shrimp trawls, which have been the most common types near the ELs. However, the potential for damage will be minimized because Nexen will provide the location of each abandoned or suspended well to fishers, DFO (including Science Branch), DND, Coast Guard and to the Canadian Hydrographic Service which will chart these locations as hazards, enabling trawlers to avoid them. In either case, no vessels transiting over these areas are expected to be affected after abandonment.

As discussed above, the ELs have historically seen very little recorded domestic fishing activity and low levels of foreign fishing compared to other grounds on and near the Grand Banks, so that the loss of fishing opportunity resulting from avoiding these geographically limited locations by mobile vessels would be very low, even with the potential future return of the shrimp fishery and any growth of other

trawl fisheries in the future. Similarly, if there were plans in the future to lay another cable or other infrastructure in the area it would need to avoid the specific location of remaining wellhead components but it is not anticipated that avoidance of these specific locations would affect those plans in any material way.

Given the implementation of mitigation measures, the resulting residual adverse environmental effects on fisheries and other ocean uses resulting from well abandonment or suspension, including the potential for continued presence of abandoned or suspended wellhead structures in certain areas, are expected to be negligible in magnitude, localized, short-term to permanent in duration, sporadic in occurrence, and potentially irreversible as some portions these abandoned wellheads may remain above the seabed.

13.3.8 Supply and Servicing

The operation of supply and servicing ships and other Project-related vessel movements (including the transits of MODUs) have a potential to interact with fisheries and other ocean uses if they interfere with fishing operations or the passage or safety of other ships. They also pose a potential risk of causing damage to fishing gear, particularly fixed gear which may be left to “soak” in the water without a fishing boat attending nearby.

Within the Project Area itself, where all drilling-associated activity will occur except for transits to and from the shore base, most activity will be focused in or near the MODU safety zones, including a dedicated stand-by vessel which will attend each MODU throughout the drilling program and usually remain within the safety zone. As noted above and discussed in Section 7.2 , the Project Area has usually experienced relatively low domestic and foreign fishing activity, with very little recorded fixed gear in use, which will also reduce the likelihood of Project vessel interactions with such marine activities. Ongoing information exchanges with fishing entities, any military operations and direct communications with other ships at sea (which are typically larger vessels at these distances from shore, well equipped with communication technology), and the use of AIS and radar will further assist to limit any potential interactions.

The greater potential for fishing and other vessel interactions with Project-related vessels is during port transits through the waters west of the Project Area. Project transits to and from port may include ships carrying personnel and supplies, and any vessels required for servicing or otherwise supporting the drilling operations. It is expected that there will be two to three return transits per week while a MODU is operating, increasing to a total of four to five if two MODUs are operating at the same time. These Project-related activities between port and the Project Area will be typical of current ship movements, and - as discussed in Section 7.2 - the increase to existing marine traffic serving the offshore and domestic and international marine transportation in the region will be negligible. As with shipping within the Project Area, information exchanges, direct at-sea communications, and the use of AIS and radar will further serve to prevent interactions and mitigate any effects along supply and servicing routes between port and the Project Area.

For fishing gear, much of this area can be the location of unattended set crab pots, particularly within the April – July period. As described in Section 7.2, these pots are weighted to the bottom and not subject to interference from shipping, but each string of pots has an attached buoy or buoys at the surface. However, service and supply vessels will not be towing sub-surface equipment (as a seismic

ship would, for example) and therefore pose no greater risk of conflicts than does other shipping that typically transits the Grand Banks on routes to and from the Island of Newfoundland, and between many other Canadian, US and European ports. If an event does occur between a Project vessel (or any other Project equipment or escaped debris) outside a mandatory Safety Zone, the Project's fisheries loss or damage compensation program will be available to address the loss.

Project-related vessel activity in the Project Area or between Project operations and ports will also generate underwater sound and other environmental discharges. As noted above, the increase in the area's marine traffic owing to Project vessels will be negligible and sound generated by the ships' engines will be the same in type as those generated by any fishing or other commercial vessel of equivalent size. Consequently, underwater sound emission levels attributable to Project service vessels are not expected to be increased over existing anthropogenic ambient levels and will continue at approximately the same intensity as generated by current traffic. As discussed in Section 8.3, a detectable difference in behavior or distribution of commercial fish species is not likely because of the short-term, transitory and localized nature of such operations. Discharges from Project-related vessels, such as deck drainage and grey or black water have the potential to affect fishers if there is a change in water quality affecting fish or fouling fishing gear. However, any discharge of wastes associated with all Project-related vessels will also be in accord with the OWTG and other mitigation measures outlined in Sections 2.9 and 8.3.2.

For transits between the Project Area and a port in Eastern Newfoundland, it is expected that at least some personnel will be carried by helicopter, which will have little or no potential for adverse interaction with fisheries or other ships at sea.

With mitigations in place, residual environmental effects on fisheries and other ocean uses associated with supply and servicing transits within the Project Area and traffic routes to and from port are therefore predicted to be negligible in magnitude, localized, short-term in duration, occurring regularly, and reversible following Project completion.

13.4 Environmental Effects Evaluation

The predicted residual effects from the Project's planned activities and the determination of the significance of these effects on the fisheries and other ocean uses VC are summarized in this section.

13.4.1 Residual Environmental Effects Summary

Although some commercial fisheries activities have a potential to be affected, depending on the location and timing of Project and fishing activities, the effects will be transient and affect very small portions of the Project Area, where fishing activity has usually been low. The same is the case for potential effects on other marine users and uses. With the implementation of the various mitigations described in the preceding sections and summarized in Tables 13.5 and 13.6 below, the Project is likely to result in negligible to low magnitude, localized, short-term adverse environmental effects on fisheries and other ocean uses.

Table 13.5 Environmental Effects Assessment Summary: Fisheries

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

Summary of Existing Conditions and Environmental Context

- The Project Area is located over 400 km from the closest port, on the slope and rise of the Grand Banks east of Canada's EEZ, within fisheries areas managed by both DFO and NAFO
- Commercial fishing for different species takes place within the LSA with the summer months usually being the times when such offshore areas experience the most activity
- Important commercial fisheries (domestic and foreign) include those for snow crab (and formerly Northern shrimp) and some groundfish species in directed or by-catch fisheries
- Available domestic fisheries data indicate that relatively low levels of harvesting occur within the LSA this is also suggested by the more limited data available for foreign fisheries.
- Except for snow crab, which is concentrated westward from the Project Area, the great majority of harvesting that does occur is with mobile fishing gear.

Key Mitigation Measures (See Section 13.3.2)

- Continuing information updating and exchange about fishing locations and timing, and about Project plans and activities.
- Establishment and communication of safety zones.
- Strict management of marine discharges.
- Implementation of a program for Fishing Gear or Vessel Damage or Loss Compensation.
- Use of FLOs and a SPOC as needed, during relevant activities
- Issuance of Notices to Shipping / Mariners.
- Provide locations for in situ wellheads to Transport Canada / Canadian Hydrographic Services for inclusion on nautical charts.

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• Direct interference with fishing activity or exclusion from established fishing grounds • Damage to fishing gear or vessels • Decreases in the abundance, distribution and actual or perceived quality of fisheries resources	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges (including fluids and cuttings)	• Damage to fishing gear or vessels • Decreases in the abundance,	N-A	N	L-PA	S-M	S	R	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
	distribution and actual or perceived quality of fisheries resources							
Vertical Seismic Profiling	• Direct interference with fishing activity or exclusion from established fishing grounds • Damage to fishing gear or vessels • Decreases in the abundance, distribution and actual or perceived quality of fisheries resources	N-A	N	L	S	S	R	H
Well Testing	• Decreases in the abundance, distribution and actual or perceived quality of fisheries resources	N-A	N	L	S	S	R	H
Well Abandonment or Suspension	• Direct interference with fishing activity or exclusion from established fishing grounds • Damage to fishing gear or vessels	N-A	N	L	S-P	S	R-I	H
Supply and Servicing	• Direct interference with fishing activity or exclusion from established fishing grounds	N-A	N	L	S	R	R	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
	• Damage to fishing gear or vessels • Decreases in the abundance, distribution and actual or perceived quality of fisheries resources							

Evaluation of Significance

Not Significant

- The Project is not likely to result in significant adverse environmental effects on Fisheries.
- The establishment of a safety zone around MODUs will temporarily prevent harvesters from accessing those grounds, and may require some diversion around them, but the Project is unlikely to have a significant adverse environmental effect on the overall domestic or foreign fisheries, particularly considering the past record of fishing activity within the ELs.
- The implementation of standard mitigation practices and measures for Fisheries, such as gear damage compensation, establishment of a safety zone around any active MODU, the presence and active advice of a FLO as required, Notice to Shipping/Mariners, and other on-going communications and information exchanges will further reduce the potential for interactions and consequent effects.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

Table 13.6 Environmental Effects Assessment Summary: Other Ocean Uses

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

Summary of Existing Conditions and Environmental Context

- The LSA is located on the slope and rise of the Grand Banks east of Canada's EEZ in international waters (the High Seas), over 400 km from the Island of Newfoundland
- Canadian and international vessels (primarily tankers and cargo ships) regularly travel through the LSA on route to destinations in North America, Europe, the Mediterranean and beyond.
- In addition to vessels transiting through the region, the other principal marine traffic on the eastern Grand Banks undertakes or supports other offshore petroleum exploration and production operations, mainly in the Jeanne d'Arc Basin area
- Three active subsea Europe – North America communications cables are known to pass through the LSA
- Canadian and or allied military operations (surveillance, monitoring, training, rescue) may occur on or beyond the Grand Banks
- No military Legacy Sites are known to exist in the project Area, but undocumented UXO may be present

Key Mitigation Measures (See Section 13.3.2)

- Establishment and communication of safety zones
- Issuance of Notices to Shipping / Mariners
- Provide locations for in situ wellheads to Transport Canada / Canadian Hydrographic Services for inclusion on nautical charts
- Avoidance of other offshore petroleum installations, safety zones
- Coordination with other petroleum exploration operations
- Monitoring the location of other vessels (radar, AIS, direct at-sea radio communications)
- Adherence to the *Canada Shipping Act, 2001* (and *Collision Regulations*)
- Avoiding existing subsea cables when drilling
- Communications with MARLANT about activities and following Military Notices (Annual Notices to Mariners)
- Observing for and reporting UXOs

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• Direct contact with in situ marine component • Interference with other marine activities	A	L	L-PA	S-M	R	R	H
Drilling and Associated Marine Discharges (including fluids and cuttings)	• Direct contact with in situ marine component	N-A	N	L-PA	S-M	S	R	H
Vertical Seismic Profiling	• Interference with other marine activities	N-A	N	L	S	S	R	H
Well Testing	• None expected	N	-	-	-	-		H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
Well Abandonment or Suspension	• Interference with other marine activities	N-A	N	L	S	S	R	H
Supply and Servicing	• Interference with other marine activities	N-A	N	L	S	R	R	H

Evaluation of Significance

Not Significant

- The Project is not likely to result in significant adverse environmental effects on other ocean uses.
- The establishment of a safety zone around MODUs will temporarily prevent ships from transiting these limited areas and will require diversion around them if the zones were directly on a vessel's course, but the Project is unlikely to have an significant adverse environmental effect on domestic or foreign shipping, military operations, activities related to other offshore petroleum exploration or production operations, existing subsea communication cables or UXOs
- The implementation of appropriate marine communications, use of AIS, adherence to Canadian and international navigational standards, avoidance of existing cables and petroleum installations, and monitoring for UXOs will further reduce the potential for interactions and consequent effects.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

13.4.2 Determination of Significance

With the implementation and application of the proposed mitigation measures to avoid or reduce residual environmental effects on fisheries and other ocean uses, the Project is not predicted to result in significant adverse environmental effects on fisheries or other ocean uses.

This prediction has been made with a high level of confidence based on a good understanding of the area's fisheries (including fisheries science surveys) and other marine components and activities in the area, and the general effects that the many past oil and gas exploration projects in the Atlantic Canadian offshore have had on such activities. The primary mechanism of interaction that may have adverse effects on this VC is the presence of the MODU with its associated safety zone. Although the safety zone is a mitigation measure to avoid conflicts with other vessels and fishing gear, it does mean the loss of some potential fishing grounds. While this has a potential to result in a decrease in the area available to be harvested or otherwise used, the effect is anticipated to be negligible to minor and spatially and temporally limited. It is therefore not anticipated that the Project will cause a detectable reduction in the overall intensity or value of any activity or result in a decrease in overall activity levels.

13.5 Environmental Monitoring and Follow-up

As described above, Nexen has committed to various mitigation measures and continuing processes to avoid or reduce the potential for adverse interactions with and effects on fisheries and other ocean uses. These include on-going communication and information exchange mechanisms throughout the Project. These are intended to allow for the on-going consideration of Project related activities and any issues that might arise during the Project, and to work collaboratively to assess, plan and implement any further mitigation measures that might be required during the life of the Project. In particular, annual EA updates and reports on past activities will provide continuing opportunities for consultation and evaluation and to understand and address any changes in the fisheries environment or science survey plans.

Given the high level of confidence regarding the prediction of no significant adverse environmental effects on fisheries and other ocean uses in the Project Area, the LSA or the RSA, and the implementation of mitigations, no follow-up is proposed to be implemented for planned Project activities.

14 ATMOSPHERIC ENVIRONMENT: ENVIRONMENTAL EFFECTS ASSESSMENT

The atmospheric environment includes various components of the physical environment, including air quality and greenhouse gases (GHGs) and air temperature, acoustic and light conditions. The main potential interactions between planned Project activities and the atmospheric environment relate to air emissions associated with the presence and operation of the MODUs and their associated on-board equipment, as well as vessel and aircraft traffic and other Project-related activities such as well testing and evaluation. This chapter considers the potential effects of the Project on these aspects of the physical environment, including each of the sub-components referenced above.

In addition to the importance and function of the atmospheric environment in and of itself, there are clear interactions and inter-relationships between it and other components of the natural and socioeconomic environments, including several of the other VCs considered elsewhere in this EIS. Potential effects on this VC may, for example, have potential effects on the marine biota that may come into contact with Project-related emissions, as well as for physical health and well-being of adjacent people and communities. The atmospheric environment can therefore represent a potential pathway for Project-related environmental effects to interact with and affect other aspects of the biological and socioeconomic environments. Where applicable, the potential for Project-related atmospheric emissions to affect other environmental components has been considered as part of the environmental effects assessments for these other VCs.

Heat emissions from the MODUs and other equipment, such as those generated by engines and flaring, will be dissipated to the atmosphere without any anticipated interactions with receptors or resulting environmental effects. On-board lighting will also be required for any and all Project activities that occur at night, and must be in place and activated for safety and regulatory compliance reasons. Light emissions from the MODUs will include platform lighting, as well as those which may be associated with any flaring that is required during well testing. Light will also be generated by the supply vessels for navigation and deck lighting purposes, Flaring activity during a formation flow test will also generate light and thermal emissions. In addition, atmospheric noise will likewise be generated by the operation of the MODU and associated equipment. Heat, light and noise emissions resulting from the Project are not assessed further within the atmospheric environment VC itself. They are, however, considered as part of the effects assessments for other VCs, where they constitute environmental disturbances that may have adverse effects on the VC in question (such as for marine birds, see Chapter 9).

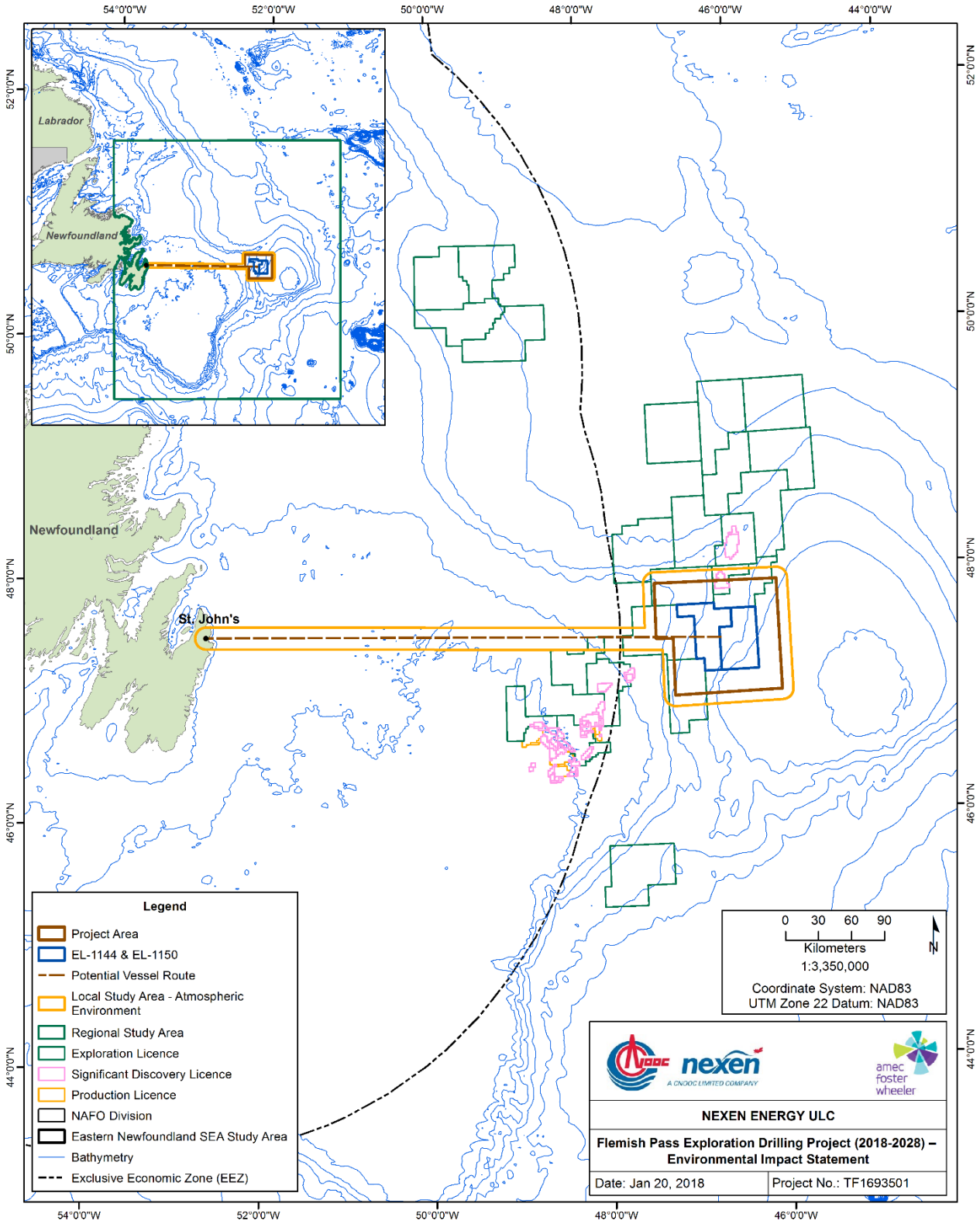
14.1 Environmental Assessment Study Areas and Effects Assessment Criteria

This section defines the Study Areas (spatial and temporal boundaries) for the environmental effects assessment for this VC, as well as the evaluation criteria that are used to define and determine the significance of the Project's predicted environmental effects.

14.1.1 Spatial Boundaries

A number of spatial assessment boundaries have been defined for the environmental effects assessment, which reflect the varying ways and scales in which the Project may influence the atmospheric environment. These are defined as follows (Figure 14.1).

Figure 14.1 Atmospheric Environment: Environmental Assessment Study Areas



Project Area: This area encompasses the overall geographic area offshore Eastern Newfoundland within which all planned Project-related exploration activities will take place. This includes ELs 1144 and 1150, within which drilling will occur, as well as a surrounding 20 km buffer area to account for any ancillary activities (such as walk away VSP surveys) that may extend outside the boundaries of the ELs themselves. While the Project Area is defined as an overall polygon that encompasses all such activities over the course of the Project, the various activities associated with the drilling of each individual well and other planned components will occupy fairly small areas within this overall area, as described in Chapter 2. The assessment also considers related supply vessel and aircraft traffic to and from this offshore Project Area.

Local Study Area (LSA): This area represents the anticipated environmental zone of influence of the Project's planned components and activities with respect to this VC. It therefore encompasses the overall geographic area over which Project-related atmospheric emissions will occur. Atmospheric emissions during planned activities will likely be detectable only within several kilometers of the source and the immediate vicinity of the associated vessel and aircraft traffic routes to the ELs. For this VC, the LSA is therefore (conservatively) defined as the offshore Project Area and the associated vessel and aircraft traffic route, and an appropriately 10 km area around these.

Regional Study Area (RSA): The overall RSA for the environmental effects assessment is as defined and illustrated earlier in Section 4.3.1, and encompasses both the LSA for this VC as defined above, as well as other projects and activities off Eastern Newfoundland whose relevant environmental effects (atmospheric emissions) may interact directly with those of this Project.

14.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the potential duration of Project-related activities in the Project Area (2018-2028, see Section 2.7), as well as the likely timing of any resulting environmental effects.

14.1.3 Environmental Effect Significance Definitions

It is within the above described spatial and temporal boundaries that the Project's potential environmental effects on this VC and their significance are assessed and evaluated.

Where they exist, applicable environmental legislation and regulations can help set criteria and thresholds related to any atmospheric emissions from a project, and for evaluating their potential significance. Although failure to meet an applicable regulatory criterion may be an important regulatory compliance issue, it may however not have measurable or material environmental implications in the context of a specific area or environmental component or condition.

Significant environmental effects are considered to be those that could cause a change in the VC that would alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this EIS, significant environmental effects on the atmospheric environment are defined as those that would cause one or more of the following:

> Air Quality: *A Project-related, detectable decrease to existing air quality conditions that results in measurable, repeated and prolonged exceedances of applicable regulatory standards and*

guidelines, and/or changes in ambient air quality that are predicted to result in detectable adverse effects on one or more of the other VCs considered in this EIS.

GHG Emissions*: A Project-related incremental increase in GHG emissions that results in a quantifiable increase to overall anthropogenic climate change influences at the provincial and/or national level.*

14.2 Potential Environmental Changes, Effects and Associated Parameters

As described in Section 2.9.1, atmospheric emissions resulting from planned Project activities will include exhaust from the MODU(s), supply vessels and aircraft and their associated equipment (such as on-board power generators), as well as emissions from the storage and flaring of hydrocarbons associated with well testing if and as required. An estimate of the various air emissions that will be associated with the Project, by key component and activity, is provided in this chapter.

The potential environmental effects of the Project on this VC are summarized in Table 14.1, along with the identification of key parameters through which these Project-related changes and effects may be reflected.

Table 14.1 Potential Project-Related VC Environmental Changes and Resulting Effects: Atmospheric Environment

Potential Environmental Changes	Potential Environmental Effects	Associated Parameter(s)
• The Project has the potential to affect air quality through emissions of air pollutants associated with MODU operations, vessel and aircraft traffic, and other equipment use, as well as well testing.	*Change in Air Quality*	• Types and levels of Project-related emissions, in relation to ambient conditions and any applicable regulations and standards
• The Project will release GHGs associated with MODU operations, vessel and aircraft traffic, and other equipment use, as well as well testing	*Change in GHG Levels*	

An overview of the potential for each of the Project's planned components and activities to result in one or more of the above noted potential environmental effects on this VC is presented in Table 14.2.

Table 14.2 Potential Project-VC Interactions and Associated Effects: Atmospheric Environment

Planned Project Component / Activity	Potential Environmental Effects	
	Change in Air Quality	Change in GHG Levels
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	●	●
Drilling and Associated Marine Discharges (including fluids and cuttings)		
Vertical Seismic Profiling	●	●

Planned Project Component / Activity	Potential Environmental Effects	
	Change in Air Quality	Change in GHG Levels
Well Testing	●	●
Well Abandonment or Suspension	●	●
Supply and Servicing	●	●

14.3 Environmental Effects Assessment and Mitigation

The potential effects of the Project's planned components and activities on the atmospheric environment are assessed and evaluated in the following subsections.

14.3.1 Approach and Methods

As noted above, atmospheric emissions will occur throughout the course of planned Project activities, the primary sources of which will be the engines of the MODU and the associated supply vessels and aircraft. Depending on the type of formation flow test carried out, atmospheric emissions could also result if flaring is undertaken, and for the purposes of this EIS it is assumed that flaring would be required.

Calculated estimates of atmospheric emissions from planned Project activities are provided in the following subsections, with the analysis focussing on those activities that are most relevant to potential emissions to the atmospheric environment, namely:

- Presence and Operation of MODUs
- Well Testing
- Supply and Servicing

Anticipated emissions from these sources include products of fuel combustion, mainly criteria air contaminants (CACs, particulate matter, carbon monoxide [CO], sulphur oxides [SO_x], nitrogen oxides [NO_x]) and GHGs. Three classes of particulates were considered: total particulate matter (TPM), fine particulate matter less than 10 microns (PM_{10}) and fine particulate matter less than 2.5 microns ($PM_{2.5}$). Other emissions from fuel combustion may include trace metals and volatile organic compounds (VOCs); however, these are expected to be minor and have not been quantified.

14.3.2 Summary of Key Mitigation

Mitigation measures that will be implemented to help avoid or reduce potential environmental effects on the atmospheric environment include:

- The frequency of vessel and aircraft traffic transits associated with the Project will be minimized to the extent possible.

- Flaring will be kept to the minimum amount necessary to characterize the hydrocarbon accumulation and as necessary for the safety of the operation. High efficiency burners will be used when flaring is required.

- Engines will be operated and maintained according to manufacturer's recommendations.

- Emission sources will comply with applicable limits set out in Canada's *Vessel Pollution and Dangerous Chemicals Regulations.*

- Sulphur content in diesel fuel used for the Project will meet current regulatory requirements (as per Regulation SOR/2002-254).

14.3.3 Presence and Operation of MODUs

As described in Section 2.5, the Project may involve the drilling of up to 10 wells over its planned temporal duration. Specific wellsite locations and well designs will be selected and defined as Project planning activities move forward. Wells may be drilled using either harsh environment semi-submersible and/or drill ship MODUs, which will be provided and operated by a third party drilling contractor. It is possible that at times there could be two MODUs involved in Project-related drilling activities in different parts of the Project Area simultaneously.

14.3.3.1 Semi-Submersible MODU Option

As the particular MODU(s) to be used for the Project have not yet been selected the analysis included in this chapter is based on the consideration of a representative, or "proxy" MODU. The West Aquarius, operated by Seadrill (see Figure 2.3, Section 2.5.1), has been selected as a proxy semi-submersible MODU due to its previous experience operating in this region and in similar environmental conditions as those found in the Project Area. (Specifications available at *http://www.seadrill.com/~/media/Files/S/Seadrill/our-fleet/technical-sheet/west-aquarius-spec-7-17-15.pdf*).

The West Aquarius is powered by eight diesel-fueled Wartsila engines, each having a power output rating of 6,312 horsepower (hp). The following conservative operating conditions and assumptions were used to calculate the potential atmospheric emissions from the MODU:

- Wartsila engines have the lowest fuel consumption over a wide operating range;

- Engines are equipped with SCR system to reduce NOx emissions;

- All engines are running simultaneously and at full capacity;

- The average daily fuel consumption is 56 m^3/day (50 MT/day), which includes a standby vessel;

- Sulphur content in diesel fuel used in the engines will meet current regulatory requirements; and

- The amount and duration of drilling is based on two wells at 160 days each (including a well test) and eight wells at 75 days each, totally 920 drilling days for the Project overall.

The emissions estimates for the MODU presented in Table 14.3 were calculated using factors from the United States Environmental Protection Agency (US EPA) "AP-42 Compilation of Air Emission Factors" for large stationary diesel engines (US EPA 1996) and the above listed assumptions.

Table 14.3 Estimated Emissions from Semi-submersible MODU Operations

Group	Compound	Emission Factor*	Emission Rate		
			Hourly (kg/hr)	Daily (active day) (t/day)	Project (Total t)
Criteria Air Compounds	NO_x	1.90E+00 lb/MMBtu	1042.75	25.03	23,024.03
	CO	8.50E-01 lb/MMBtu	466.50	11.20	10,300.22
	SO_2	1.01E-01 lb/MMBtu	55.43	1.33	1,223.91
	TPM	1.00E-01 lb/MMBtu	54.88	1.32	1,211.79
	PM_{10}	8.22E-02 lb/MMBtu	45.12	1.08	996.21
	$PM_{2.5}$	7.98E-02 lb/MMBtu	43.78	1.05	966.65
*US EPA AP-42, Section 3.4 "Large Stationary Diesel and All Stationary Dual-fuel Engines", table 3.4-1 Used for Diesel fuel: 1 gallon = 137,000 BTU					

14.3.3.2 Drill Ship MODU Option

As mentioned above, a drill ship could be used for some or all of the wells drilled as part of this Project. Again, given their previous experience operating in this region and/or in similar environmental conditions as those found in the Project Area, the Stena Carron (specifications available at: *http://www.stena-drilling.com/fleet-availability/stena-carron*) or Stena IceMax (specifications available at: *http://www.stena-drilling.com/fleet-availability/stena-icemax*) were used as proxy drill ships for the purposes of this analysis.

The main power engines for these ships are as follows:

- *Stena Carron*: 6 x Wartsila 16V32 x 7.45 MW
- *Stena IceMAX*: 6 x Wartsila 16V32C x 7.68 MW

The following conservative operating conditions and assumptions were used to calculate atmospheric emissions from this representative MODU:

- All engines are running simultaneously and at full capacity;
- The average daily fuel consumption is 45 m^3/day (39.4 MT/day);
- Sulphur content in diesel fuel used in the engines will meet current regulatory requirements; and
- The amount and duration of drilling is based on two wells at 160 days each (including a well test) and eight wells at 75 days each, totally 920 drilling days for the Project overall.

The emissions estimates presented in Table 14.4 were calculated using factors from the US EPA "AP-42 Compilation of Air Emission Factors" for large stationary diesel engines (US EPA 1996) and considering the above listed above assumptions.

Table 14.4 Estimated Emissions from Drill Ship MODU Operations

Group	Compound	Emission Factor		Emission Rate		
				Hourly (kg/hr)	Daily (active day) (t/day)	Project (Total t)
Criteria Air Compounds	NO_x	1.90E+00	lb/MMBtu	837.93	20.11	18501.45
	CO	8.50E-01	lb/MMBtu	374.86	9.00	8276.96
	SO_2	1.01E-01	lb/MMBtu	44.54	1.07	983.50
	TPM	1.00E-01	lb/MMBtu	44.10	1.06	973.76
	PM_{10}	8.22E-02	lb/MMBtu	36.26	0.87	800.52
	$PM_{2.5}$	7.98E-02	lb/MMBtu	35.18	0.84	776.77

As illustrated in the tables above, when compared to the estimated semi-submersible MODU emissions, there are lower emission rates estimated for all criteria air compounds (approximately 20 percent lower) when the drill ship option is considered.

GHGs emissions are therefore also expected to be lower from the drill ship than from the semi-submersible MODU. Based on above calculations and comparison the semi-submersible MODU was selected as a “worst case” scenario, and so the drill ship has been excluded from further assessment.

14.3.4 Well Testing

If there is an indication of commercial hydrocarbons found during an exploration drilling program a well flow test may be conducted to sample and identify formation fluids (which may contain hydrocarbons and/or water) and to measure produced flow rates. During such testing, produced fluid is flowed back to the MODU, where hydrocarbons are separated from any produced water and samples are collected and analyzed. Produced hydrocarbons and some produced water are flared using high-efficiency burners supplied by a third party company.

The following operating conditions and assumptions were used to calculate emissions from any such well testing that may be carried out as part of this Project:

- For the purposes of these calculations, two wells are tested and each test is expected to last up to two days (total number of well testing days therefore equals four); and

- An estimated 10,000 Mcf (10,000,000 cubic feet) of gas and 36,000 barrels of oil are flared per tested well.

The emissions estimates presented in Table 14.5 were calculated using factors from the US EPA “AP-42 Compilation of Air Emission Factors” for natural gas combustion (Section 1.4) and fuel oil combustion (Section 1.3) and considering the various operating conditions and assumptions referenced above.

Table 14.5 Estimated Emissions from Well Testing

Group	Compound	Emission Factor		Emission Rate		
		Gas* lb/10^6scf	Oil** lb/1000gal	Hourly (kg/hr)	Daily (active day) (t/day)	Project (Total t)
Criteria Air Compounds	NO_x	100	55	796.01	19.10	76.42
	CO	84	5	79.45	1.91	7.63
	SO_2	0.6	157.00	2,245.31	53.89	215.55
	TPM	1.9	12.41	177.66	4.26	17.05
	PM_{10}	1.9	12.41	177.66	4.26	17.05
	$PM_{2.5}$	1.9	12.41	177.66	4.26	17.05
*US EPA AP-42, Section 1.4 "Natural Gas Combustion". **US EPA AP-42, Section 1.3 "Fuel Oil Combustion".						

14.3.5 Supply and Servicing

The offshore exploration program will involve vessel and aircraft use, including supply traffic to, from, and within the Project Area.

14.3.5.1 Vessels

During active drilling operations it is expected that three offshore supply vessels will support the MODU. One vessel will provide dedicated standby support in close proximity to the MODU (included and considered in the preceding sections under MODU operation), while two additional offshore supply vessels will perform materials and personnel transfer operations between the MODU and a not yet identified shorebase in Eastern Newfoundland. For each well (active MODU) these materials and personnel transfer operations are expected to result in up to three return trips per week throughout the duration of a drilling operation.

These supply and service vessels will be provided and operated by a third party contractor. As the particular vessels to be used for the Project have not yet been selected, the analysis included in this chapter is again based on the consideration of a "proxy" vessel. The Avalon Sea, operated by Secunda (see Figure 2.3, Section 2.5.1), has been selected as a proxy supply vessel for the purposes of these emissions calculations, due to its previous experience operating in this region and in similar environmental conditions as those found in the Project Area (Specifications available at: *http://www.secunda.ca/vessel-avalon.php*).

The Avalon Sea is powered by four diesel fueled engines, each having a power output rating of 2,880 kilowatts (kW). The vessel is also equipped with an auxiliary and emergency generator with power output ratings of 700 kW and 200 kW, respectively. The following conservative operating conditions and assumptions were used to calculate worst case air emissions from the supply vessels:

- All engines are running simultaneously and at capacity;
- The travel distance for the supply vessel used for the assessment is 527 km each way;

- The average travelling speed is 24 kilometres per hour (km/hr, which is the maximum speed for this vessel, and thus conservative regarding fuel consumption);

- The amount and duration of use is based on two wells at 160 days each (including a well test) and eight wells at 75 days each;

- Estimated three round trips (48 hrs each) per week during the days for which there is an active MODU at a wellsite location;

- The average daily fuel consumption is 64 m^3/day (56MT/day); and

- Sulphur content in diesel fuel used in the engines will meet current regulatory requirements.

The estimated emissions presented in Table 14.6 were calculated using factors from the US EPA "AP-42 Compilation of Air Emission Factors" for large stationary diesel engines (US EPA 1996) and considering the various operating conditions and assumptions referenced above. The total number of operating days for supply vessels (based on the number of trips and the average speed) is 789 days.

Table 14.6 Estimated Emissions from Supply Vessels

Group	Compound	Emission Factor		Emission Rate		
				Hourly (kg/hr)	Daily (active day) (t/day)	Project (Total t)
Criteria Air Compounds	NO_x	1.90E+00	lb/MMBtu	1,191.72	28.60	22554.15
	CO	8.50E-01	lb/MMBtu	533.14	12.80	10090.01
	SO_2	1.01E-01	lb/MMBtu	63.35	1.52	1198.93
	TPM	1.00E-01	lb/MMBtu	62.72	1.51	1187.06
	PM_{10}	8.22E-02	lb/MMBtu	51.56	1.24	975.88
	$PM_{2.5}$	7.98E-02	lb/MMBtu	50.03	1.20	946.92
*US EPA AP-42, Section 3.4 "Large Stationary Diesel and All Stationary Dual-fuel Engines", table 3.4-1 Used for Diesel fuel: 1 gallon = 137000 BTU						

14.3.5.2 Aircraft

Helicopters will also be used for the transportation of personnel and key materials to and from the MODU(s) as required throughout the course of the Project. Aircraft support will be supplied by a third party licensed operator under contract to Nexen, and is expected to be based at an existing facility at St. John's International Airport. Based on current practice in the Newfoundland and Labrador offshore oil industry, it is assumed that the Sikorsky S-92 helicopter will be used (Specifications available at: http://www.cougar.ca/Fleet/sikorsky-s92.asp). It is estimated that there would be up to three helicopter transits per day to an active MODU. The following operating conservative conditions and assumptions were used to calculate emissions from the helicopters:

- The travel distance for the supply vessel used for the assessment is 527 km each way;
- The average travelling speed is 252 km/hr;

- Fuel consumption rate for the Sikorsky helicopter is 735 kilograms per hour;
- Estimated three round trips per day during the days for which there is an active MODU at a wellsite location;
- The amount and duration of use is based on two wells at 160 days each (including a well test) and eight wells at 75 days each; and
- Sulphur content in fuel used in the engines will meet current regulatory requirements.

The emissions calculations presented in Table 14.7 were estimated using data from "Guidance on the Determination of Helicopter Emissions" (Rindlisbacher and Chabby 2015) for all compounds except SO2. The data from Rindlisbacher and Chabby (2015) are direct measurements based on source testing and specific to the make and model of the helicopter. Since data for SO_2 were unavailable from Rindlisbacher and Chabby (2015), emissions were calculated using the methodology in the article "Quantifying Atmospheric Emissions in Oil Gas Industry" (Thapa 2016) which is based on fuel consumption and sulphur content.

Based on above information (distance, number of trips, and speed) the operating hours for the helicopter are calculated to be 12.5 hours per day which corresponds to 344 days of helicopter usage over the duration of the Project. It is recognized that the particular hours of operations per day might change due to daylight constraints and other considerations. It is expected that during drilling operations there would be a maximum of 10 flights per week for personnel transfers with flying occurring on five days per week, so the assumptions used for emission calculations are considered conservative.

Table 14.7 Estimated Emissions from Helicopter Operations

Group	Compound	Emission Factor	Emission Rate		
			Hourly* (kg/hr)	Daily (active day) (t/day)	Project (Total t)
Criteria Air Compounds	NO_x	Note 1	10.59	0.13	45.65
	CO	Note 1	1.10	0.01	4.74
	SO_2	1.20E-01 t/t	0.87	297.97	417.16
	TPM	Note 1	0.27	0.003	1.17
	PM_{10}	Note 2	0.27	0.003	1.17
	$PM_{2.5}$	Note 2	0.27	0.003	1.17
* Guidance on the Determination of Helicopter Emissions" (Rindlisbacher & Chabby 2015)					
Notes: 1. Hourly emission rates were taken from a helicopter emissions study by Rindlisbacher and Chabby (2015) that measured a shortlist of compounds from various engine models. 2. Particulate sizes were below $PM_{2.5}$ in the helicopter emissions guidance document (Rindlisbacher and Chabby 2015), therefore, the total particulate emission rate was applied to PM_{10} and $PM_{2.5}$. 3. The SOx emission factor was taken from a publication "Quantifying Atmospheric Emissions in Oil Gas Industry" (Thapa 2016), that calculates the SOx emission factor (t emissions/t fuel) from air transport using the formula 2 x S where S is the sulphur content in fuel.					

14.3.6 Summary

The estimated air contaminant emissions resulting from the Project were estimated as described above and are presented in Table 14.8.

Table 14.8 Project Emissions of Criteria Air Compounds

Activity	Project Emission Rate (t/project)			
	NO_x	**CO**	**SO_2**	**TPM**
MODU	23,024.03	10,300.22	1,223.91	1,211.79
Well Testing	76.42	7.63	215.55	17.05
Supply Vessels	22,554.15	10,090.01	1,198.93	1,187.06
Helicopters	45.65	4.74	297.97	1.17
Total	**45,700.25**	**20,402.61**	**2,936.36**	**2,417.07**

14.3.7 Greenhouse Gases

For the analysis of GHGs, the following definitions have been used in this assessment:

> *Carbon dioxide equivalent (CO_{2e}):* A unit of measure used to allow the addition of, or the comparison between, gases that have different global warming potentials (GWPs). Since many GHGs exist and their GWPs vary, the emissions are added in a common unit, CO_{2e}. To express GHG emissions in units of CO_{2e}, the quantity of a given GHG (expressed in units of mass) is multiplied by its global warming potential.
>
> *Global warming potential (GWP):* Calculated as the ratio of the time-integrated radiative forcing (i.e., the amount of heat-trapping potential, measured in units of power per unit of area, e.g. watts per square meter) that would result from the emission of 1 kilogram (kg) of a given GHG to that from the emission of 1 kg of CO_2. GWPs were taken from the Intergovernmental Panel on Climate Change's Fourth Assessment Report "Climate Change 2007: Synthesis Report" (IPCC 2007) as shown in Table 14.9.

Table 14.9 Global Warming Potentials

Greenhouse Gas	Formula	100 year GWP
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298

Emissions are calculated as the sum total mass of each of the gases or gas species multiplied by their respective GWP.

The emission factors from the *Guidance Document for Reporting Greenhouse Gas Emissions for Large Industry in Newfoundland and Labrador* (Government of Newfoundland and Labrador Office of Climate Change 2017) used to calculate the GHG emissions for the MODU, supply vessel and helicopter are presented in Table 14.10 and the calculated emissions, by individual GHG, for all Project activities are presented in Table 14.11.

This guidance document provides guidance similar to some Canadian provinces (Ontario, British Columbia and Quebec), and some US states which are members of the Western Climate Initiative Inc. (WCI). It is also similar to the guidance provided by Environment and Climate Change Canada. The WCI provides technical services to support the implementation of US state and Canadian provincial GHG emissions trading programs, including a GHG reporting protocol.

Table 14.10 GHG Emission Factors

GHG	Project Activity				
	MODU (g/L)	Supply Vessels (g/L)	Helicopters (g/L)	Well Testing	
				Gas (g/m^3)	Oil (g/L)
CO_2	2663	2663	2534	2482	2663
CH_4	0.13	0.13	0.08	6.5	0.13
N_2O	0.4	0.4	0.23	0.06	0.4

Table 14.11 Project Total GHG Emissions by Activity

Activity	Emission Rate (t/project) for the Project			
	CO_2	CH_4	N_2O	CO_2e
MODU	137,198	7	21	143,510
Well Testing	35,405	6	5.1	37,076
Supply Vessels	134,398	7	20	140,581
Helicopters	8,727	0.28	0.79	8,970
Total	315,727	20	47	330,138

The overall GHG emissions over the period 2018 to 2028 of the project are estimated to be 330 kilotonnes (kt) CO2e (average 30 kt CO2e annually). These GHG predictions are informational and provided to place the Project in an industry, provincial and regional context. The current Federal guidance document (FTPTCCCEA 2003) states that "…unlike most project-related environmental effects, the contribution of an individual project to climate change cannot be measured." To provide context for the relative magnitude of Project GHG emissions, the total annual GHG emissions for 2015 for the Province of Newfoundland and Labrador was 10.3 Mt CO2e and the total Canadian GHG inventory was 722 Mt CO2e that same year (ECCC 2017); the Project represents approximately 0.29 percent of the provincial inventory and 0.004 percent of the national 2015 inventory. In 2015, 189 Mt CO2e was attributed to the oil and gas sector; the Project represents approximately 0.016 percent of the oil and gas sector GHG emissions in 2015.

The aggregate GHG emissions from the Project are compared with provincial and federal targets for 2020 and 2030 as shown in Table 14.12.

Table 14.12 GHG Emissions Comparison to Provincial, Federal and Global Targets

	Provincial		Federal	
	2020	2050	2020	2030
	8.6 Mt	7.5 Mt	622 Mt	524 Mt
Project	0.35%	0.40%	0.005%	0.006%

14.4 Environmental Effects Evaluation

This section summarizes the residual effects of the Project on the atmospheric environment and presents a determination of significance for the environmental effects assessment for this VC.

14.4.1 Regulatory and Policy Contexts

The Project will operate in accordance with the *Canadian Environmental Protection Act.* ECCC sets health-based air quality objectives for pollutant concentrations in ambient air for fine particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and ozone with work underway to develop standards for nitrogen dioxide. These Canadian Ambient Air Quality Standards (CAAQS) are concentration based values driving the improvement of air quality across the country. In addition, Project-related emissions will be in compliance with the IMO relevant regulations and emission limits under MARPOL.

Currently, there is no federal regulatory requirement to reduce GHGs. However, the federal government has indicated they will implement federal legislation that will mandate a national carbon pricing program by 2018 (ECCC 2017). At the federal level, GHG emission reduction targets have also been set and include the following (ECCC 2016):

- *Canada*: 17 percent reduction below the 2005 level by 2020 at the 15th Conference of the Parties, sessions conducted as part of the United Nations Framework Convention on Climate Change, an international treaty established in 1992 to address climate change (ECCC 2017);

- *Canada*: 30 percent reduction below the 2005 level by 2030 at 21st Conference of the Parties (ECCC 2017); and

- *Newfoundland and Labrador*: 10 percent reduction below the 1990 level by 2020 and a 75- 85 percent reduction below the 2001 level by 2050 as set out in "Charting Our Course: Climate Change Action Plan 2011" (CCEEET 2011).

The federal regulation SOR/2002-254 set limits for sulphur content in diesel fuel for use on-road, off-road, in rail (locomotive), marine vessels, and stationary engines in order to decrease SO_2 emissions. As per the regulation, the marine vessels have to use fuel with sulphur content no more than 1,000 ppm (phased in May 31, 2014).

In Newfoundland and Labrador, air quality is regulated by the *Air Pollution Control Regulations* which were established in 2004. GHGs are regulated by the *Management of Greenhouse Gas Act*. However, given the offshore location of the Project it is not likely that these provincial regulations will apply to it.

14.4.2 Residual Environmental Effects Summary

Atmospheric emissions from planned Project activities will produce a localized, transient effect on air quality. Due to the distance from shore air quality effects on onshore areas and receptors are very unlikely. Since the predicted GHG emissions from the Project are low and insignificant in comparison to GHG targets, the Project will have virtually no effect on current estimates of future global climate change.

14.4.3 Determination of Significance

As described above and summarized in Table 14.13 below, the Project is not likely to result in significant adverse environmental effects on this VC. This conclusion has been determined with a high level of certainty based on the nature and scope of the Project, knowledge about the existing environment within the LSA and RSA, and current understanding of the effects of similar projects on the VC.

14.5 Environmental Monitoring and Follow-up

No specific environmental monitoring or follow-up related to this VC is considered necessary in relation to the Project.

Table 14.13 Environmental Effects Assessment Summary: Atmospheric Environment

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *	
Summary of Existing Conditions and Environmental Context • The existing ambient air quality within the Project Area can be generally categorized as good, and is likely occasionally and locally influenced by exhaust emissions from marine vessel and aircraft traffic and from the operations of the existing oil production platforms and other sources.	**Key Mitigation Measures (See Section 14.3.2)** • The frequency of vessel and aircraft traffic transits associated with the Project will be minimized to the extent possible. • Flaring will be kept to the minimum amount necessary to characterize the hydrocarbon accumulation and as necessary for the safety of the operation. High efficiency burners will be used when flaring is required. • Engines will be operated and maintained according to manufacturer's recommendations. • Emission sources will comply with applicable limits set out in Canada's *Vessel Pollution and Dangerous Chemicals Regulations*. • Sulphur content in diesel fuel used for the Project will meet current regulatory requirements (as per Regulation SOR/2002-254).

Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**						
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation)	• Change in air quality • Change in GHG levels	A	L	L-LSA	S	C	R	H
Drilling and Associated Marine Discharges (including fluids and cuttings)	• None expected	N	-	-	-	-	-	H
Vertical Seismic Profiling	• Change in air quality • Change in GHG levels	A	L	L-LSA	S	S	R	H

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
Well Testing	• Change in air quality • Change in GHG levels	A	L	L-LSA	S	S	R	H
Well Abandonment or Suspension	• Change in air quality • Change in GHG levels	A	L	L-LSA	S	S	R	H
Supply and Servicing	• Change in air quality • Change in GHG levels	A	L	L-LSA	S	R	R	H

Evaluation of Significance

Not Significant

- Atmospheric emissions from planned Project activities will produce a localized, transient effect on air quality. Due to the distance from shore air quality effects on onshore areas and receptors are very unlikely.
- Since the predicted GHG emissions from the Project are low and insignificant in comparison to GHG targets, the Project will have virtually no effect on current estimates of future global climate change.
- The Project is not likely to result in significant adverse environmental effects on this VC.

* The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *

KEY

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence
N/A	Not Applicable

14.6 References

CCEEET (Office of Climate Change, Energy Efficient and Emissions Trading) (2011). Charting Our Course: Climate Change Action Plan 2011 The Office of Climate Change, Energy Efficiency and Emissions Trading.

ECCC (Environment and Climate Change Canada) (2016). Technical Guidance on Reporting Greenhouse Gas Emissions.

ECCC (Environment and Climate Change Canada) (2017). National Inventory Report 1990–2015: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change, Part 1.

FTPTCCCEA (The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment) (2003). Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners. November 2003.

Government of Newfoundland and Labrador Office of Climate Change (2017). A Guidance Document for Reporting Greenhouse Gas Emissions for Large Industry in Newfoundland and Labrador, March 2017.

IPCC (Intergovernmental Panel on Climate Change) (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Thapa, P. (2016). Quantifying Atmospheric Emissions in the Oil Gas Industry, Memorial University of Newfoundland, September 2016.

Rindlisbacher, T. and L. Chabby (2015). Guidance on the Determination of Helicopter Emissions. Edition 2, December 2015. Report prepared for the Swiss Confederation.

US EPA (United States Environmental Protection Agency) (1996). AP 42, Chapter 3: Stationary Internal Combustion Sources, Section 3.4 Large Stationary Diesel and All Stationary Dual-fuel Engines, Fifth Edition, Volume I, October 1996.

15 CUMULATIVE ENVIRONMENTAL EFFECTS

As specified in the EIS Guidelines (Part 2, Section 6.6.3) and required under Section 19(1) of CEAA 2012, the EIS assesses and evaluates any cumulative environmental effects that are likely to result from the Project in combination with other physical activities that have been or will be carried out, as well as the significance of these potential effects.

The cumulative effects assessment considers the overall effect on the VCs as a result of any predicted residual environmental effects resulting from the Project and those of other relevant projects and activities in the RSAs (Section 4.4). The cumulative effects assessments for all VCs were completed in accordance with the approach and methods outlined below, and are reported together in this chapter.

15.1 Approach and Methods

As noted in the EIS Guidelines (Section 6.6.3), cumulative effects "are defined as changes to the environment due to the project combined with the existence of other past, present and reasonably foreseeable physical activities. Cumulative effects may result if:

- The implementation of the project may cause direct residual adverse effects on the VC, taking into account the application of technically and economically feasible mitigation measures; and,

- The same VC may be affected by other past, present and future physical activities"

The cumulative environmental effects assessment therefore considers the overall total effect on the VCs as a result of the Project's predicted residual environmental effects (as described in the preceding chapters) and those of other relevant projects and activities. As also specified in the EIS Guidelines, the approach and methods used in undertaking the assessment are based on the guidance provided in the following Canadian Environmental Assessment Agency (2014, 2015) documents:

- *Operational Policy Statement Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012 and*

- *Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012.*

15.1.1 Identification of Valued Components

The EIS Guidelines (Section 6.6.3) also state that the cumulative effects assessment will "identify and provide a rationale for the VCs that will constitute the focus of the cumulative effects assessment, focusing the cumulative effects assessment on the VCs most likely to be affected by the project and other project and activities", while also noting that "VCs that would not be affected by the project or would be affected positively by the project can, therefore, be omitted from the cumulative effects assessment." The cumulative effects assessment focusses upon the same set of VCs as those considered in the Project-specific effects assessment, as these represent the aspects of the environment that may interact with and potentially be adversely affected by the Project, and thus, upon which the Project and its residual effects may contribute to cumulative effects within the spatial and temporal boundaries under consideration.

Table 15.1 lists the various environmental components specified in the EIS Guidelines as requiring consideration in planning the cumulative effects assessment, indicating whether and how each of these are included or are otherwise being addressed.

Table 15.1 Environmental Components Listed in the EIS Guidelines and their Consideration and Inclusion in the Cumulative Effects Assessment

Environmental Components	Inclusion in the Environmental Effects Assessment		
	Project –Specific Effects Assessment	**Cumulative Effects Assessment**	**Overview / Rationale**
Fish and Fish Habitat	●	●	• Potential for residual environmental effects as a result of the Project, which may contribute to cumulative effects on a regional scale.
Migratory Birds	●	●	• Potential for residual environmental effects as a result of the Project, which may contribute to cumulative effects on a regional scale.
Marine Mammals and Marine Turtles	●	●	• Potential for residual environmental effects as a result of the Project, which may contribute to cumulative effects on a regional scale.
Species at Risk	●	●	• Potential for residual environmental effects as a result of the Project, which may contribute to cumulative effects on a regional scale. • Included in an integrated manner within each of the above listed biological components
Marine Plants			• Considered as part of the Fish and Fish Habitat VC, which is in keeping with current and standard EA practice. • Although as described in Chapter 8, the Project has little potential to interact with and adversely affect marine plants, this component is retained as part of the VC for completeness and as outlined above.
Special Areas	●	●	• Potential for residual environmental effects as a result of the Project, which may contribute to cumulative effects on a regional scale.
Commercial Fisheries	●	●	• Potential for residual environmental effects as a result of the Project, which may contribute to cumulative effects on a regional scale.
Indigenous Peoples	●	●	• Although as described in Chapter 12, the Project has little potential to adversely affect Indigenous Peoples, this component is considered in the cumulative effects assessment to systematically examine whether there is any potential for it to in any way contribute to cumulative effects. • This is considered appropriate and prudent given the overall number and diversity of Indigenous communities, activities and interests that the EIS Guidelines require be considered, and the very wide geographic

Environmental Components	Inclusion in the Environmental Effects Assessment		
	Project –Specific Effects Assessment	**Cumulative Effects Assessment**	**Overview / Rationale**
			distribution of these communities throughout Eastern Canada.
Air Quality and Greenhouse Gases	●	●	• Potential for residual environmental effects as a result of the Project, which may contribute to cumulative effects on a regional scale.
Human Environment			• Relevant aspects of the human environment that have the potential to be affected by the Project (such as commercial fisheries and other marine users) and/or which are required to be considered in the EIS under relevant provisions of CEAA 2012 (such as, for Indigenous Communities and Activities ,those factors required under Section 5(1)(c) of the Act) are part of the other socioeconomic VCs identified above.
Other			• No other environmental components have been identified through the EIS analysis or associated engagement activities as having the potential to be materially affected by the Project, and therefore requiring inclusion in the Project-specific or cumulative effects assessments.

As noted above, no other components of the biophysical or socioeconomic environments have been identified as having the potential to be directly and adversely affected by the Project which would necessitate their inclusion in the cumulative effects assessment presented in this EIS.

15.1.2 Spatial and Temporal Boundaries

The EIS Guidelines (Section 6.6.3) go on to state that the EIS will "identify and justify the spatial and temporal boundaries for the cumulative effect assessment for each VC selected". The EIS Guidelines also state that "the boundaries for the cumulative effects assessments will generally be different for each VC considered", noting that "these cumulative effects boundaries will also generally be larger than the boundaries for the corresponding project effects."

For all VCs, the spatial and temporal boundaries used for the cumulative effects assessment are consistent with those established and used for the Project-specific effects assessment (see earlier RSA definitions, Section 4.3.1). This is the case because these boundaries were defined to incorporate: 1) the likely geographic and temporal zones of influence of the Project and its environmental effects; 2) the overall geographic extents and distribution patterns of the various biota and human activities that comprise the VCs and which may therefore be affected by the Project and its potential environmental effects, and 3) the other projects and activities that may affect the same individuals or populations as those affected by the Project (whether these occur within or outside the RSA itself).

As described in Section 4.3.1, the RSA has also been established to be larger than the likely and predicted extent of Project-related effects, in order to account for the larger movements and distributions of the various biological and socioeconomic components that may be affected by the Project. These areas therefore also consider the overall distributions and movements, as applicable, of potentially affected individuals and populations. and thus, the area over which they may be affected cumulatively as a result of other projects and activities and their effects.

15.1.3 Sources of Potential Cumulative Effects

The EIS Guidelines (Section 6.6.3) state that the cumulative effects assessment should "specify other projects or activities that have been or that are likely to be carried out that could cause effects on each selected VC within the boundaries defined, and whose effects would act in combination with the residual effects of the project". A general listing of the other physical activities that are considered in the cumulative effects assessment is provided in Table 15.2, which includes various past, on-going and future projects and activities off Eastern Newfoundland and elsewhere. Where the particular locations and/or geographic extents of these other projects and activities at present and/or within the temporal duration of the Project are defined and known, this information is summarized on Figure 15.1, including an overall indication of their distances from the Project Area and LSA. This includes, for example, the locations of the four offshore production projects, commercial fishing activity (see also more detailed Figures in Section 7.2), and various other human components and activities (Section 7.3).

Table 15.2 Other Projects and Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview	Spatial and Temporal Considerations
Hibernia Oilfield	• Discovered in 1979, the Hibernia Oilfield is operated by HMDC, and is located approximately 315 km east-southeast of St. John's, NL. • The development phase of that project commenced in late 1990 and continued until the mating of the GBS and its topsides at Bull Arm NL in 1997, after which the platform was towed to and installed at its site on the Grand Banks in June of that year. • With estimated recoverable reserves of approximately 1.4 billion barrels, commercial production from the Hibernia field commenced in November 1997 and is on-going. • In recent years, the project has been further expanded to include the Hibernia South Extension Unit, from which production commenced in 2011.	• This on-going project is located approximately 135 km from the closest edge of the Project Area. • Production activities at this oilfield (and associated vessel traffic and other supporting activities) are planned to extend throughout the temporal duration of this Project.
Terra Nova Oilfield	• Discovered in 1984 and declared a significant discovery in 1985, this oilfield has reserve estimates of approximately 500 million barrels of recoverable oil.	• This on-going project is located approximately 125 km from the closest edge of the Project Area • Production activities at this oilfield (and associated vessel traffic and

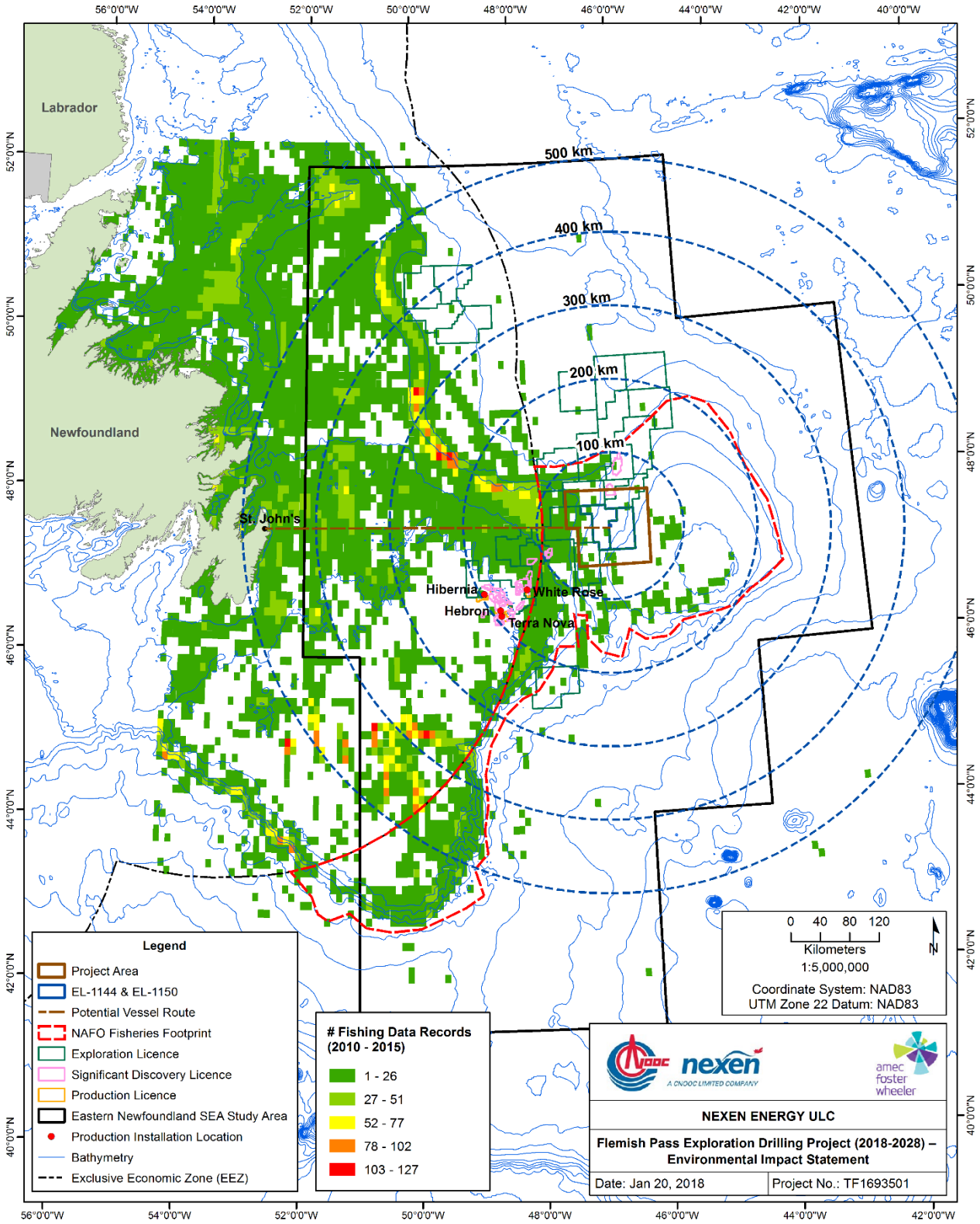
Project / Activity	Overview	Spatial and Temporal Considerations
	• The Terra Nova Project is currently in operation by Suncor Energy Inc. using a FPSO vessel, and is located approximately 350 km southeast of St. John's and 35 km southeast of Hibernia. • Dry-dock construction of the Terra Nova FPSO vessel began in early 1999, and it arrived at Bull Arm in May 2000 where outfitting, hook-up and commissioning of the vessel took place. • The FPSO arrived at the oilfield in August 2001 and began producing oil in January 2002.	other supporting activities) are planned to extend throughout the temporal duration of this Project.
White Rose Oilfield and Extension	• Discovered in 1984, a significant discovery licence for the field was issued in January 2004. It is located about 350 km east-southeast of St. John's, and 50 km from the Hibernia and Terra Nova fields. • Husky Energy is the Operator and majority owner of the White Rose field and satellite extensions. • The original White Rose field was developed using subsea technology, consisting of three drill centres tied back to an FPSO vessel. Production is provided by subsea wells in the Southern and Central drill centres while surplus gas is re-injected into the Northern Drill Centre for future extraction. The North Amethyst and South White Rose extensions all produce back to the SeaRose FPSO. • The West White Rose Project will access further resources to the west of the field, using a fixed rig tied back to the existing SeaRose FPSO. First oil is expected in 2022.	• This on-going project is located approximately 80 km from the Project Area. • Production activities at this oilfield (and associated vessel traffic and other supporting activities) are planned to extend throughout the temporal duration of this Project.
Hebron Oilfield	• First discovered in 1980, this oilfield is estimated to contain more than 700 million barrels of recoverable resources. • The Hebron Platform was towed to field in June 2017. The Project is designed for an oil production rate of 150,000 barrels of oil per day. • First oil from the Hebron Project occurred in late November 2017.	• This project is located approximately 125 km from the Project Area • Production activities at this oilfield (and associated vessel traffic and other supporting activities) are planned to extend throughout the temporal duration of this Project.
Offshore Petroleum Exploration –	• Offshore geophysical survey programs are often planned and conducted to get an overall understanding of regional geology and hydrocarbon potential, and to help	• There are a number of offshore seismic programs in the Eastern Newfoundland Offshore Area that were previously approved and are

Project / Activity	Overview	Spatial and Temporal Considerations
Seismic / Geophysical and Other Exploration Activities	identify particular sites or zones that may warrant further investigation, such as through eventual exploration drilling activities (see below). • These may include two-dimensional (2D), three-dimensional (3D) and possibly four dimensional (4D) seismic data acquisition, as well as associated geochemical, environmental and geotechnical survey activities. • Over the period 2014 to 2016 an average of approximately 390,000 km of seismic survey data (2D, 3D and other) was collected annually in the Eastern Newfoundland offshore region, with an average of about 35,000 undertaken annually in the Jeanne d'Arc Basin area (C-NLOPB 2017a).	underway, were approved but not in progress, or are still undergoing regulatory review. as of the time of EIS writing (see *http://www.cnlopb.ca/assessments*). • While exploration projects and activities are typically proposed and approved through the EA process as multi-year programs that can cover quite large offshore areas, the particular type and level of activity conducted each year can also vary and is usually a fraction of the overall scope assessed.
Offshore Petroleum Exploration - Drilling	• As of November 30, 2017 a total of 448 wells had been drilled in the Canada-NL Offshore Area, including 168 exploration wells, 56 delineation wells, and 223 development wells (C-NLOPB 2017b)	• The Eastern Newfoundland Offshore Area is also subject to on-going and planned offshore exploration drilling programs which were previously approved and are underway, were approved but not in progress, or are still undergoing regulatory review. (see *http://www.cnlopb.ca/assessments*). • The type and amount of offshore exploration activity can vary considerably from year to year throughout the Eastern Newfoundland offshore. • Figure 1.1 and all of the mapping in this EIS show the locations of existing ELs and other licences off Eastern Newfoundland, as well as any current Call for Bids Areas, identified Sectors and other relevant licensing areas.
Fishing Activity	• Fisheries within and around the Project Area and in the larger RSA are extensive and diverse, and involve fishing interests from Newfoundland and Labrador, elsewhere in Canada and various other countries. • These fisheries involve a range of species, gear types and other characteristics.	• The known spatial and temporal characteristics of these fisheries are described in detail in Chapter 7 of this EIS.
Other Marine Vessel Traffic	• This includes tanker traffic and supply vessels associated with the existing offshore oil developments, as well as cargo	• Occurs throughout the region, throughout the year.

Project / Activity	Overview	Spatial and Temporal Considerations
	ships and fishing vessel transits (see Chapter 7).	
Hunting Activity	• Wildlife (especially seabird) populations off Newfoundland and Labrador are subject to hunting activity.	• Little or no hunting activity is expected to occur in the far offshore locations that comprise the Project Area. • These activities may, however, affect the bird populations that occur in, and move to and through, the region.

Any other projects and activities that may be relevant to the cumulative effects assessment are identified and considered on a VC-specific basis, as applicable. This includes any other past, present and reasonably foreseeable projects and activities within the RSA, and/or whose environmental effects will potentially affect the same VCs (individuals and populations) as those which will be affected by the Project.

Figure 15.1 Other Projects and Activities Considered in the Cumulative Effects Assessment



15.1.4 Assessing Cumulative Effects on Each VC

Section 6.6.3 of the EIS Guidelines specify that the EIS will "assess the cumulative effects on each VC selected by comparing the future scenario with the project and without the project. Effects of past activities (activities that have been carried out) will be used to contextualize the current state of the VC."

Past and on-going projects and activities and their environmental effects are reflected in the existing baseline environmental conditions for each VC, as described in Chapters 6-7 of this EIS. The current condition of the VC as a result of natural and anthropogenic factors, and its overall sensitivity or resiliency to further disturbance or change, has been considered in a fully integrated manner throughout the environmental effects assessments. This includes predicting the likely nature and degree of the potential effects of this Project on the VC, as well as any potential effects resulting from other, multiple sources of future disturbance, as described below. The cumulative effects assessment also summarizes and considers whether and how this existing, pre-Project environmental condition may be changed by the introduction of the Project and its potential residual environmental effects, as determined and described in the preceding Project-specific environmental effects assessment (Chapters 8 to 14).

Other future projects and activities that are relevant to the VC and its cumulative effects assessment are then considered in the analysis. These comprise certain or reasonably foreseeable future physical activities that will affect the same VCs as the Project, and whose effects on the VC would likely overlap in space and time with those of the Project and/or would affect the same individuals, populations, or communities as the Project (Table 15.3). The cumulative effects assessment therefore focusses on determining and considering the likely nature and spatial and temporal characteristics of the residual environmental effects of the Project, of the affected environmental components and systems, and the environmental effects of other relevant projects and activities within these areas and time periods.

In cases where the predicted residual environmental effects of the Project on the VC will likely accumulate or interact with those of one or more other such projects and activities, the potential cumulative effects of the Project in combination with these other activities are assessed and evaluated This includes considering the potential implications for the VC resulting from multiple sources and types of environmental change, including the likely future condition of the environment both with and without the Project. Any analytical methods and assumptions used in the VC specific cumulative effects assessments are clearly defined and described, and where available and applicable, the assessment utilizes relevant scientific, engineering, community, stakeholder, and Indigenous knowledge and perspectives.

Table 15.3 Other Projects and Activities Considered in the Cumulative Effects Assessment and their Potential Relevance to Each VC

Project / Activity	**VCs Potentially Affected**						
	Marine Fish and Fish Habitat	**Marine and Migratory Birds**	**Marine Mammals and Sea Turtles**	**Special Areas**	**Indigenous Peoples**	**Fisheries and Other Ocean Uses**	**Atmospheric Environment**
Hibernia Oilfield	●	●	●	●	●	●	●
Terra Nova Oilfield	●	●	●	●	●	●	●
White Rose Oilfield and Extension	●	●	●	●	●	●	●
Hebron Oilfield	●	●	●	●	●	●	●
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	●	●	●	●	●	●	●
Offshore Petroleum Exploration - Drilling	●	●	●	●	●	●	●
Fishing Activity	●	●	●	●	●	●	●
Other Marine Vessel Traffic	●	●	●	●	●	●	●
Hunting Activity		●	●		●		

15.1.5 Mitigation

The cumulative effects assessment includes the identification and consideration of technically and economically feasible mitigation measures that Nexen will implement to avoid or reduce potential environmental effects. These include measures intended to avoid or reduce the potential effects of the Project (as identified and considered in Chapters 8 to 14), and thus the Project's contribution to any cumulative environmental effects. Where relevant, however, the assessment also considers any additional mitigation that may be required and applicable to cumulative effects only, as well as any other relevant mitigation that may be the responsibility of parties other than Nexen or its contractors.

Information on other projects and activities and their known or likely environmental effects and planned mitigations has been obtained through existing and publicly available information sources. The assessment considers the nature, location and timing of these other projects and their known or potential environmental effects in relation to the Project, as well as environmental protection measures which are known and/or required to be implemented including those required under applicable legislation, regulations and other requirements. The assessments of cumulative effects presented here are therefore not based on information or assumptions regarding mitigation measures by other proponents that would require discussions with, and confirmation by, other parties.

15.1.6 Determination of Significance

The significance of any predicted residual cumulative environmental effect is evaluated using the same VC-specific significance definitions as those used in the Project-specific effects assessments (see Chapters 8 to 14).

15.1.7 Follow-up

The cumulative effects assessment concludes with the identification and discussion of any environmental follow-up programs that may be required “to verify the accuracy of the assessment or to dispel any uncertainty concerning the effectiveness of mitigation measures for certain cumulative effects” (EIS Guidelines, Section 6.6.3).

15.2 Marine Fish and Fish Habitat (including Species at Risk)

15.2.1 Past and On-going Effects (Baseline)

Marine fish and their habitats in the Project Area, LSA, RSA and in the larger Northwest Atlantic have been and are being affected by a variety of natural and anthropogenic influences. These include past and on-going fishing activity, offshore petroleum exploration and production, general vessel traffic and other human activities (both planned and routine, as well as illegal activities and accidental events), as well as the effects of climate change and other natural and anthropogenic processes (Amec 2014; Cordes et al 2016). These have all collectively, and to varying degrees, influenced the presence, distribution and abundance of fish and invertebrate species in particular areas, depths and times, as well as the overall size and health of fish populations. The Fish and Fish Habitat VC (Section 6.1 and Chapter 8) includes fish and invertebrate species and the habitats upon which they depend. These include commercially and/or ecologically important species that are considered secure, as well as those listed as species at risk.

In the Northwest Atlantic, regime shifts have occurred over the past several decades where declines in groundfish species were linked to changing water temperatures combined with overharvesting in the late 1980s into the mid-1990s (Kulka 2011; Christensen et al 2014; Nogueira et al 2017), which coincided with an increase in prey species, including snow crab and shrimp, on the Grand Banks and Flemish Cap. Recently, these prey species have, in turn, declined in response to the recovering groundfish stocks and other factors (Nogueira et al 2015, 2017). Commercial fishing efforts continue to influence commercial and non-commercial fish populations in the Northwest Atlantic (Edinger et al 2007; Clark et al 2016; Nogueira et al 2017), as well as affecting corals and sponges which are sensitive, habitat forming species that are distributed primarily on the slopes of the Grand Banks and Flemish Cap (Edinger et al 2007; Clark et al 2016; Guijarro et al 2016; Ragnarsson et al 2017). On the Flemish Cap, for example, species density has been declining across depth assemblages since the mid to late 2000s (Nogueira et al 2017) as a result of changes in fishing pressure and the effects of climate change. Oceanographic variability through the Atlantic multidecadal oscillation also has implications for all trophic levels, resulting in increased plankton and fish productivity during warm periods and the reverse in cold conditions (Drinkwater et al 2014).

The effects of previous activities and natural environmental influences are reflected in the existing baseline environmental conditions for this VC, as described in Section 4.3.2. This includes considering the current condition (health or quality) of potentially affected fish and invertebrate populations and their habitats, and their potential resiliency or sensitivity to further environmental change as a result of the Project and other on-going and future projects and activities that may affect the same VC.

15.2.2 Potential Project-Related Contributions to Cumulative Effects

As described in Chapter 8, offshore exploration drilling and associated activities may affect marine fish and fish habitat in various ways, including through possible injury, mortality or behavioral effects due to noise or other disturbances in the marine environment, effects to benthic communities through the alteration of marine habitats and change in habitat and food availability or quality from direct disturbances or associated discharges.

The Project will interact to a degree with fish and their habitats within the Project Area, although as described in Chapter 8 it will entail a relatively minor, localized and temporary environmental disturbance at any one location. Any marine discharges will be treated prior to release in accordance with regulatory requirements, reducing any associated effects on the environment. Modelling of released drilling fluids and cuttings has also indicated that these will have a relatively small and localized footprint, reducing any resulting smothering effects on benthic species. To further reduce the potential for effects on sensitive benthic habitats (corals), seabed investigations will be conducted and appropriate set-backs applied where these species are observed within the immediate vicinity of a planned well site. Acoustic noise from VSP will largely be directed into the well, resulting in reduced area of potential effect over a short period. Furthermore, employed mitigations, including the presence of MMOs and the gradual ramp-up of air-guns promote temporary avoidance of the area by mobile species while operations are ongoing will help to reduce exposure to species. Other planned Project activities likewise represent localized and short-term activities and associated environmental disturbances, which are addressed through standard mitigations and which are not anticipated to adversely affect this VC. With the implementation of the various mitigation measures outlined in this EA, the Project will not result in significant adverse environmental effects to marine fish and fish habitat.

15.2.3 On-Going and Future Projects and Activities and Their Effects

In terms of other on-going and future projects and activities which may affect fish and fish habitat within the Project Area and RSA (Table 15.4), the fishing industry will continue to be a key influence, resulting in fish catches (mortality) and habitat disturbance through current and future fishing practices. The spatially and temporally extensive (and rather dynamic) nature of fishing activity throughout the region (in terms of fishing locations, seasons, gear types and key species) makes it somewhat difficult to predict specific areas and times from year to year for both domestic and foreign fleets, and thus, the potential for interactions between activities and their effects. However, it is anticipated that there will be some degree of overlap between the effects of these fishing activities and the environmental zone of influence of this Project over its duration.

The Eastern Newfoundland Offshore Area is also subject to on-going and planned offshore oil and gas exploration and production activities within and outside the RSA. While each of the four existing production projects represents a relatively large scale and long-term operation in this offshore area, and have associated environmental emissions and interactions related to this VC, these projects and their environmental zones of influence are for the most part, far away from those which may be associated with this Project (Table 15.4). EEM programs for three of the operational production facilities (Hibernia, Terra Nova, White Rose and associated expansions) have found project-induced environmental changes to sediment or benthic organisms to be limited to the area immediately surrounding the developments, with no indication of significant adverse environmental effects (Stantec 2012; Terra Nova 2013, Husky Energy 2017). Details on EEM study designs, methods and results to date are available

at http://www.cnlopb.ca/environment/projects.php. The RSA is also subject to other on-going and planned offshore seismic programs, exploration drilling projects and other activities which have commenced, approved or are being subject to regulatory review as of the time of writing (Table 15.4). Offshore petroleum exploration and development activities also have associated vessel traffic, and there are vessel movements associated with fishing vessels, cargo transport, and other marine activities that will continue to occur throughout the region (Section 7.3).

Table 15.4 Marine Fish and Fish Habitat: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on the VC				Spatial and Temporal Considerations
	Change in Habitat Availability and Quality	Change in Food Availability and Quality	Change in Fish Mortality, Injury, Health	Change in Fish Presence and Abundance (Behavioral Effects)	
Hibernia Oilfield	•	•	•	•	• Hibernia EEM program has shown barium levels from drill cuttings do not vary from baseline up to 1 km from platform. EEM sediment toxicity tests showed microtox responses west of platform up to 6 km away and toxic responses in amphipods up to 3 km from the platform. • Fish health and body burden measures were similar between American plaice sampled within 1 km of platform and fish in the reference area 60 km away (Stantec 2012) • EEM has therefore indicated that environmental changes attributed to the project are limited with regard to the spatial extent and magnitude of chemical contaminants, and similarity, of fish health parameters between the platform area and the reference area 50 km away (Stantec 2012).
Terra Nova Oilfield	•	•	•	•	• Terra Nova EEM has shown that barium levels in sediment decreased to background within 1 km of drill centres (Terra Nova 2013). Increased abundance of benthic invertebrates within 1-2 km of drill centres associated with higher barium and hydrocarbon concentrations were observed during the EEM (Whiteway et al 2014). • The EEM program has indicated no change in fish health indices in relation to produced water discharge (Mathieu et al 2011).

Project / Activity	Potential Effects on the VC				Spatial and Temporal Considerations
	Change in Habitat Availability and Quality	Change in Food Availability and Quality	Change in Fish Mortality, Injury, Health	Change in Fish Presence and Abundance (Behavioral Effects)	
White Rose Oilfield and Extension	•	•	•	•	• The White Rose Oilfield EEM has indicated that hydrocarbon concentration was correlated with distance up to 5.8 km from the drill centre. The EEM indicated that the distance over which barium concentration was correlated with distance to drill centres was approximately 1 km. Fish health indices were not different from reference area for American plaice and snow crab collected within 4 km of drill centres (Husky Energy 2017).
Hebron Oilfield	•	•	•	•	• It is estimated that WBM based drill cuttings deposition would be 12.8 km^2 total around the Platform and MODUs being used (Stantec 2011). Disposal of SBM drill cuttings will be by reinjection into wells with some disposal of treated SBM drill cuttings into the environment (Amec Foster Wheeler 2017).
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	•	•	•	•	• These types of offshore exploration activities have been widely carried out off Eastern Newfoundland and elsewhere, typically utilize relatively standard equipment and techniques, and are subject to general environmental protection requirements and mitigations that are based in regulation and other guidelines. • Project-specific EAs for these projects in the Canada-NL Offshore Area therefore typically conclude that with the implementation of these mitigations, they are not likely to result in significant adverse environmental effects (see *http://www.cnlopb.ca/assessments*). • Although the often extensive survey areas covered by some types of offshore seismic surveys can increase the potential for spatial interactions between their potential effects and those of other activities in the marine environment, most proposed seismic survey activities operate for a very short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence.

Project / Activity	Potential Effects on the VC				Spatial and Temporal Considerations
	Change in Habitat Availability and Quality	Change in Food Availability and Quality	Change in Fish Mortality, Injury, Health	Change in Fish Presence and Abundance (Behavioral Effects)	
Offshore Petroleum Exploration Activity - Drilling	•	•	•	•	• As noted above, these types of offshore exploration activities have been widely carried out off Eastern Newfoundland and elsewhere, typically utilize relatively standard equipment and techniques, and are subject to general environmental protection requirements and mitigations that are based in regulation and other guidelines. • Project-specific EAs for these projects in the Canada-NL Offshore Area therefore typically conclude that with the implementation of these mitigations, they are not likely to result in significant adverse environmental effects (see *http://www.cnlopb.ca/assessments*). • Drilling and other types of exploration activities are typically relatively short-term and localized activities. This can reduce the potential for individuals and populations to be affected simultaneously and repeatedly by multiple projects and activities
Fishing Activity	•	•	•	•	• Commercial fishing activity in the RSA is extensive and diverse, involving a variety of participants, species, gear types, and occurring year round. • The available fisheries geospatial data does not indicate, however, that the Project Area itself is a core area for commercial fishing (See Chapter 7).
Other Marine Vessel Traffic		•	•	•	• Vessel movements are highly transitory with limited environmental effects, minimizing potential effects in any particular location and time.
Hunting Activity					• Not applicable to this VC

15.2.4 Potential Cumulative Environmental Effects

The Project will have the potential to interact with fish and their habitats within the LSA, although as described the planned activities will be temporary, localized and with limited Project-induced changes at any one location and time throughout the duration of the Project. The relatively small and localized areas of environmental disturbance associated with the Project will mean that these effects will not likely accumulate or interact with other such projects and activities in the region. While there is little potential for the direct "footprint" or environmental zones of influence of Project-related disturbances or effects to accumulate with those of other projects and activities, it is recognized that the widespread and often migratory nature of some fish species increases the potential for individuals and populations to be affected by multiple perturbations in various locations. In addition, the often extensive areas and times covered by some types of marine activities (e.g., offshore seismic surveys) can further increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment.

In terms of commercial fishing activity in particular, the Project Area and LSA for this VC are located well outside of the key areas for fishing, as reflected in the domestic fishing activity maps presented in Section 7.2 (which are based on DFO fisheries information for the 2010-2015 period), which minimizes the potential for direct effect interactions. It does, however, overlap with the identified NAFO "fisheries footprint" (Figure 15.1) which defines the key areas used by foreign fleets, although it avoids the identified highest intensity fishing areas within that footprint (see Section 7.2). Although the migratory nature of some fish species is recognized, the temporary and localized nature of Project-related disturbances and the planned and required implementation of safety zones around these activities (within which fishing activity will be prohibited) will somewhat reduce the potential for direct interactions between activities and their effects, and thus, any cumulative effects on fish and fish habitat from the Project in combination with commercial fisheries.

Other petroleum exploration activities in this region, such as offshore seismic and other surveys and associated vessel traffic, will also contribute to cumulative effects on this VC, and there are various on-going and planned exploration programs in the Flemish Pass and surrounding region. The environmental effects of these activities are, however, quite localized and short-term in nature, including those resulting from offshore seismic surveys, which result in a temporary environmental disturbance at any particular location and time. In the same way, exploration drilling activity may only take place in accordance with an approved EL issued by the C-NLOPB, which gives the operator the exclusive right to conduct exploration drilling within that geographic area for the defined time period. This, along with the relatively limited geographic zone of influence associated with the environmental disturbances that result from offshore drilling (Section 8.3), including the areas covered by any drill cuttings accumulations around these wellsites, means that there is limited potential for overlap and interaction between disturbances and eventual effects. These factors will aid in reducing spatial and temporal interactions between the effects of this Project and seismic and exploratory drilling activities that may be taking place simultaneously elsewhere.

Each of the current oil and gas production projects off Eastern Newfoundland are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from on-going EEM programs (Table 15.4). There is therefore little potential for interaction of accumulation of the environmental effects from the Project and those associated with these existing production projects in the Jeanne d'Arc Basin.

Marine vessel traffic is also common in these offshore areas, although inherently transient in nature with limited environmental disturbances. Such traffic is also likewise required to remain specified distances from active offshore exploration drilling and seismic programs in the region, which will limit the potential for effect interactions.

15.2.5 Species at Risk

As described in the existing environment description for marine fish and fish habitat (Section 6.1), there are some 19 species with conservation designations that do or may occur in the Project Area and surrounding marine environments. These include several wolffish species, Atlantic cod, cusk, American eel, Atlantic salmon, American plaice, bluefin tuna, and a number of species of grenadier, redfish, sharks and skates. Section 6.1 also provides a detailed overview of the various natural and anthropogenic factors and influences that have affected these species and have contributed to their current ’at risk` designations, and that information is therefore not repeated here.

As with secure fish species, species at risk may potentially interact with Project activities based on occupation of various habitats at different life history stages, and the same planned and proposed mitigation measures will be utilized to avoid or reduce any such adverse interactions. All of these species are highly mobile in their adult stages, and given the highly localized and short-term nature of planned Project activities and their likely environmental effects (along with the planned implementation of mitigation measures outlined previously), the Project will not have any adverse effects upon these species, nor will it affect any identified critical habitat for any such species. Furthermore, any potential for effects from the Project would be negligible in comparison to effects on these species resulting from commercial fisheries and climate change.

Therefore, the Project will not make any material or perceptible contribution to potential cumulative effects on any species at risk.

15.2.6 Cumulative Effects Summary and Evaluation

The Project activities will operate temporarily in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. This will reduce the potential for individuals and populations to be affected through multiple interactions with this Project and for species to be affected simultaneously and repeatedly by multiple projects and activities. As part of the planning and implementation of its activities over the course of this Project, Nexen will continue to communicate with relevant marine users and other stakeholders, including other oil and gas exploration companies and other marine users operating in the area, to ensure that appropriate spatial and temporal separation is maintained as required for safety, regulatory and operational reasons. This, along with the other planned Project-related mitigations that will be implemented, will reduce the potential for and degree of any associated cumulative effects on fish and fish habitat.

Table 15.5 summarizes the results of the cumulative effects assessment for this VC. As illustrated, the Project will not result in significant adverse cumulative environmental effects on marine fish and fish habitat in combination with other projects and activities that have been or will be carried out.

Table 15.5 Summary of Potential Cumulative Environmental Effects: Marine Fish and Fish Habitat

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and On-Going Activities)	• Fish presence and abundance for secure species and species at risk have been affected by directed commercial fisheries and by-catch, as well as changing oceanographic conditions. • Overall, due to warming conditions, groundfish have been recovering on the Grand Banks with a decline in groundfish prey species.
Residual Environmental Effects of the Project	• Based on the localized and temporary nature of Project-related activities and associated mitigations, confidence is high that while there may be some Project-related disturbances that affect a small number of individuals in a localized area, any effects will be reversible. • Any Project-related effects are therefore unlikely to alter the overall and long-term viability of local or regional populations.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia Oilfield	No: Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from on-going EEM programs.
Terra Nova Oilfield	No: Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from on-going EEM programs.
White Rose Oilfield and Extension	No: Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from on-going EEM programs.
Hebron Oilfield	No: The Hebron Project is located well outside of the Project Area and LSA. Based on the project's EA findings and other existing EEM programs, it will have localized environmental effects suggesting there is no potential for interaction.
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	Yes: Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigations, will minimize potential for interaction.
Offshore Petroleum Exploration Activity - Drilling	Yes: Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigations, will minimize potential for interaction.
Fishing Activity	Yes: Some potential for direct interaction, although these activities occur primarily in select parts of the Project Area / LSA only, mostly outside of the ELs. Safety zones around Project activities and other mitigations will limit the potential for overlapping and concurrent environmental effects, and thus, for cumulative effects on this VC. At the regional scale, fishing activity will continue to affect fish populations throughout the RSA.
Other Marine Vessel Traffic	Yes: Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities and other mitigations will limit the potential for overlapping and concurrent environmental effects, and thus, for cumulative effects on this VC
Hunting Activity	Not applicable to this VC.

Summary of Potential Cumulative Environmental Effects	
Cumulative Effects Summary	The Project is not likely to result in significant adverse cumulative environmental effects on fish and fish habitat in combination with other projects and activities that have been or will be carried out.

15.3 Marine and Migratory Birds (including Species at Risk)

15.3.1 Past and On-going Effects (Baseline)

The waters off Eastern Newfoundland provide important feeding areas for various marine-associated birds, some of which breed along the province's coastline. In addition, although they do not regularly occur in the offshore environment, landbirds and shorebirds may periodically pass through the area during spring and fall migration or during storm events. The distribution, abundance and health of marine and migratory birds and their populations are often influenced by both natural phenomena such as weather, food availability and oceanographic variation, as well as human activities and their associated disturbances including hunting, fishing activity, vessel traffic, offshore structures and pollution. Vessel movements associated with fishing activity and general marine traffic throughout the region, as well as previous offshore exploration and production activities may also have, to varying degrees, affected marine bird populations in the region, and hunting activity (both legal and illegal) also puts pressure on some bird populations. In addition to these local disturbances, migratory bird species may also be affected by a variety of activities and associated effects within their often very extensive ranges, including hunting, pesticides and pollution.

In general, the populations of most marine-associated bird species occurring off Eastern Newfoundland are considered stable overall (Section 6.2), although the Leach's Storm-petrel, for example, has seen considerable decline in recent years (Wilhelm et al 2015). That species is thought to be particularly vulnerable to the potential effects of offshore activities through attraction to artificial light sources resulting in collision and strandings. In addition, because they may forage hundreds of kilometres from the nest site during the breeding season (Pollet et al 2014) there may be risk of exposure of adults and eggs to oil from spills and routine discharges (Morandin and O'Hara 2016). The effects of previous and on-going projects and activities within the Project Area, LSA and RSA (and elsewhere) are reflected in, and considered as part of, the existing (baseline) environmental conditions for this VC, as described in Section 6.2.

15.3.2 Potential Project-Related Contributions to Cumulative Effects

Potential interactions with, and effects on, marine and migratory birds as a result of this Project relate primarily to possible attraction and/or disorientation of the birds around the MODU or vessels due to artificial light sources. There may also be interactions with individuals from noise and possible waste materials associated with the MODUs and other related vessel and aircraft traffic. These potential disturbances will be mitigated by ensuring compliance with relevant standards and regulations to minimize discharges and emissions from Project activities, and other planning and mitigation measures as described in Section 9.3.2.

As described in the Project-specific environmental effects assessment for this VC (Chapter 9), the planned activities associated with this Project will operate temporarily in any one location, resulting in a short-term disturbance within a predicted small zone of influence. With the implementation of the various

mitigations outlined in Section 9.3.2, the Project will not result in significant adverse environmental effects on marine and migratory birds and their habitats. Because any such effects are anticipated to be minor and spatially and temporally limited, and given the typically wide variation in marine bird presence and distribution in space and time throughout this very large offshore area, the number of individuals that may be adversely affected by the Project is not expected to have any population-level effects.

15.3.3 On-Going and Future Projects and Activities and Their Effects

As described above, offshore activities such as oil and gas exploration and production activities and general marine vessel traffic (commercial and fishing) off Eastern Newfoundland also have the potential to affect marine-associated avifauna. Moreover, the widespread and migratory nature of many marine bird species can also increase the potential for avifauna to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur. Table 15.6 provides an overview of other projects and activities that have or may affect marine and migratory birds, and thus, contribute to cumulative environmental effects on this VC within the RSA.

Table 15.6 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on the VC				
	Change in Mortality / Injury Levels and Bird Health	Change in Avifauna Presence and Abundance (Behavioral Effects)	Change in Habitat Availability and Quality	Change in Food Availability or Quality	Spatial and Temporal Considerations
Hibernia Oilfield	•	•	•	•	• Current or potential effects are similar to those that could be associated with this Project, and are primarily associated with possible implications for mortality / injury levels and habitat availability / quality due to attraction of night-flying birds to artificial lighting (including flares) and exposure/attraction to emissions and discharges from platforms and vessels (Ellis et al 2013). • Unlike the Project, however, production platforms and their associated effects are confined to a fixed location but are long-term in nature. As well, there are potential disturbance effects from vessel and helicopter traffic. • Non-routine discharges may contribute to a change in mortality/injury levels, but such effects are not anticipated. Routine discharges are expected to comply with regulation and are unlikely to cause measurable change in mortality / injury. There may be
Terra Nova Oilfield	•	•	•	•	
White Rose Oilfield and Extension	•	•	•	•	
Hebron Oilfield	•	•	•	•	

Project / Activity	Potential Effects on the VC				
	Change in Mortality / Injury Levels and Bird Health	Change in Avifauna Presence and Abundance (Behavioral Effects)	Change in Habitat Availability and Quality	Change in Food Availability or Quality	Spatial and Temporal Considerations
					a change in food availability due to discharges of organic waste. • Interactions with the VC are anticipated to be confined to within approximately 5 km of the source for lighting attraction effects (Poot et al 2008). • Operational discharges and effects of vessel and helicopter traffic are more localized (Rojek et al 2007; Hoang 2013). • The majority of strandings reported by operators occur in September and October, corresponding with the departure of Leach's Storm Petrel fledglings from the breeding colonies, and with fall landbird migration (Davis et al 2015). • Inclement weather conditions (fog, drizzle) are also associated with greater numbers of strandings.
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities, and Drilling	•	•	•	•	• Effects from other exploration drilling and other survey programs are anticipated to be similar in nature and scale to predicted Project effects (see Chapter 9), and are primarily associated with attraction to artificial lighting (including flares) and operational discharges from MODUs and vessels (Ellis et all 2013). • Although the large survey areas covered by some types of offshore seismic surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most proposed survey activities operate for a very short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. • Available research suggests these effects are therefore minor and short-term in duration for marine and migratory birds and their habitats (e.g. Davis et al 1998; MMS 2004; Dooling and Popper 2007). • There are potential disturbance effects from vessel and helicopter traffic. • Interactions with the VC are anticipated to be confined to within approximately 5 km of the source for lighting attraction effects (Poot et al 2008); operational

Project / Activity	Potential Effects on the VC				
	Change in Mortality / Injury Levels and Bird Health	Change in Avifauna Presence and Abundance (Behavioral Effects)	Change in Habitat Availability and Quality	Change in Food Availability or Quality	Spatial and Temporal Considerations
					discharges and effects of vessel and helicopter traffic are more localized (Rojek et al 2007; Hoang 2013).
Fishing Activity	•	•		•	• Entanglement in fishing gear, particularly gillnets and, to a lesser extent, longlines and bottom trawls, can cause changes in mortality and injury levels to seabirds (accidental by-catch). In Newfoundland and Labrador, murres and shearwaters are the most commonly captured (Ellis et al 2013). • Vessel lighting, disturbance and emissions/discharges from fishing vessels may cause a change in habitat quality; this change is again quite short-term and transient at any given location. • Bait and offal from fishing vessels cause change in food availability for marine birds, and this in turn may result in localized changes in presence and abundance of avifauna.
Other Marine Vessel Traffic	•	•	•	•	• Vessel traffic may affect seabirds through lighting, discharges and displacement/disturbance. • Vessels are highly transitory, minimizing effects in any particular location and time • Interactions with the VC are anticipated to be confined to within approximately 5 km of the source (Poot et al 2008). • Any vessel traffic in proximity to coastal breeding colonies and IBAs has the greatest potential for negative effects on the VC.
Hunting Activity	•				• Some types of marine birds (specifically, murres and waterfowl) can experience change in mortality / injury levels due to hunting. • Although hunting is restricted to nearshore areas, some birds are highly mobile and individuals that occur in the RSA may also be at risk of mortality due to hunting.

15.3.4 Potential Cumulative Environmental Effects

Potential interactions with, and effects upon, marine and migratory birds as a result of the Project and other projects and activities in the region relate primarily to possible attraction to offshore lighting, and

any disturbances from noise and waste materials that are often associated with these offshore activities, where these may affect the same individuals or populations. Any potential interactions with marine-associated birds as a result of the Project will, however, entail a localized and short-term disturbance at any one location and time, which reduces the potential for particular individuals and populations to be affected repeatedly through multiple interactions with this Project, as well as the potential for, and degree and duration of, any overlap between the effects of this Project and other activities in the marine environment. As indicated in the preceding table, the environmental zone of influence of each project and activity in the region is typically quite localized (especially with regards to the effects of lights and other such disturbances), and very small compared with the total amount of habitat available in the region.

The current petroleum production projects (Hibernia, Terra Nova, White Rose and Hebron) are located at considerable distance from the Project Area / LSA, and with the possible exception of associated vessel transits, any environmental disturbances that are relevant to this VC resulting from Project activities (including light emissions that may attract and/or disorient night-flying birds) in this area will not likely overlap with those of the current production projects. The environmental effects of any on-going or planned exploration activities in the region will also be localized and short-term in nature, including those resulting from offshore seismic surveys, which result in a temporary and short-term environmental disturbance (including lights and other emissions) at any particular location and time. As described earlier, exploration drilling activity may only take place in accordance with an approved EL issued by the C-NLOPB, which gives the operator the exclusive right to conduct exploration drilling within that geographic area for a defined time period. This, along with the relatively limited geographic zone of influence associated with the environmental disturbances (including lights) that result from offshore drilling (Section 9.3), means that there is little or no potential for overlap and interaction between disturbances, and for effects on the same individuals.

General vessel traffic to and through the area may affect marine-associated avifauna through lighting and other emissions, but again the highly transitory nature of these disturbances limit any effects in any particular location and time, and thus, the potential for cumulative effects to individuals. Hunting pressure on any birds that may frequent the Project Area also has potential to contribute to cumulative effects, particularly in the case of murres. Waterfowl are, however, more commonly found in coastal habitats (Section 6.2.3) and therefore less prone to interaction with the Project.

15.3.5 Species at Risk

The Project is not anticipated to result in any adverse effects on marine-associated avian species at risk, and therefore, to contribute to any cumulative effects on these species. There is no identified and designated critical habitat for avian species at risk within the Project Area / LSA or RSA, and Ivory Gull and Red-necked Phalarope are the only such species that have the potential to be found in the area on any regular basis. The Ivory Gull is generally associated with pack ice, and as such, it is more likely to occur in the northern regions of the RSA. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to pass through, but the risk of interactions with this and other projects in the area is low. Therefore, the Project will not make any material or perceptible contribution to potential cumulative effects on any avian species at risk.

15.3.6 Cumulative Effects Summary and Evaluation

Table 15.7 summarizes the results of the cumulative effects assessment for this VC. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on marine and migratory birds in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any cumulative effects on this VC within the RSA are predicted to be very low, and are not expected to be perceptible.

Table 15.7 Summary of Potential Cumulative Environmental Effects: Marine and Migratory Birds

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and On-Going Activities)	• Offshore Newfoundland provides important habitat for tens of millions of marine and migratory birds. Several major seabird colonies are also found along the Newfoundland coastline, and species that do not breed in the area are drawn to the productive Grand Banks for foraging throughout the year. • In general, the populations of most marine-associated bird species occurring off Eastern Newfoundland are considered stable, although one species, the Leach's Storm-petrel, has seen declines in recent years.
Residual Environmental Effects of the Project	• Platform attraction associated with lighting and increased foraging opportunities may increase potential for mortality or injury; however, this is anticipated to be localized and short-term, and will not have adverse effects to populations. • Discharges from offshore platforms and vessels may interact with birds both directly and indirectly. The Leach's Storm-petrel is considered especially vulnerable. • Vessel and helicopter traffic in nearshore environments may interact with birds, but will be minimized through adherence to common traffic routes where possible, and avoidance of known seabird colonies • These interactions may lead to increased potential for mortality or injury of individuals, but any such effects are anticipated to be minor and spatially and temporally limited. Project activities are not anticipated to have population-level effects. • The Project is not likely to result in significant effects on marine and migratory birds.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia Oilfield	No: Operations and associated environmental disturbances are located well outside of the LSA, with localized environmental effects.
Terra Nova Oilfield	No: Operations and associated environmental disturbances are located well outside of the LSA, with localized environmental effects.
White Rose Oilfield and Extension	No: Operations and associated environmental disturbances are located well outside of the LSA, with localized environmental effects.
Hebron Oilfield	No: The Hebron Project is located well outside of the Project Area. Based on its EA results, the project will have localized environmental effects suggesting there is no potential for interaction.

Summary of Potential Cumulative Environmental Effects	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities, and Drilling	Yes: Some potential for interaction, although localized and short term nature of these activities and their effects, along with required separation measures and other mitigations, will minimize potential for interaction.
Fishing Activity	Yes: Some potential for interaction, although these are transient activities and the available data do not indicate that the Project Area is a key fishing area. Fisheries by-catch could potentially result in cumulative changes in mortality/injury. Vessel traffic and associated emissions (including offal) could have cumulative effects on habitat quality and food availability, although these would be minor due to the spatially and temporally limited nature of these effects.
Other Marine Vessel Traffic	Yes: Some potential for interaction, although these activities and their effects are highly localized and transient. Vessel traffic and associated emissions could have cumulative effects on habitat quality and food availability, but these would be minor due to the spatially and temporally limited nature of these effects.
Hunting Activity	Yes: Hunting pressure could potentially result in cumulative changes in mortality/injury to murres and, to a lesser extent, waterfowl. Hunting activity is managed under applicable legislation / regulations and associated enforcement.
Cumulative Effects Summary	The Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

15.4 Marine Mammals and Sea Turtles (including Species at Risk)

15.4.1 Past and On-going Effects (Baseline)

The potential environmental effects of offshore projects and activities on marine mammals and sea turtles relate primarily to noise, as well as other possible environmental emissions (waste materials) and disturbances (such as vessel strikes) which may interact with these species and their habitats. Notably, however, as a result of existing marine activities in the RSA (e.g., fishing vessels, general marine traffic) and naturally occurring oceanographic sounds, the region's underwater environment is likely already quite noisy at particular locations and times. Marine mammals and sea turtles may also be affected by other natural factors and processes, as well as the disturbances which may be associated with other types of human activities in the marine environment. These include general vessel traffic and commercial fishing activity, which may result in effects due to entrapment and entanglement in fishing gear, collisions with marine vessels, and through pollution and other environmental effects. The widespread and migratory nature of marine mammals and sea turtles increases the potential for individuals and populations to be affected by multiple environmental disturbances in various locations, and thus, for cumulative effects to occur. This is reflected in the fact that many of the marine mammals and sea turtles that comprise this VC have been designated (and are therefore protected) as species at risk or are otherwise of conservation concern. Again, the effects of previous and on-going projects and activities within the RSA (and elsewhere) are reflected in, and considered as part of, the existing (baseline) environmental conditions for this VC.

15.4.2 Potential Project-Related Contributions to Cumulative Effects

As discussed in detail in Chapter 10, potential interactions with marine mammals and sea turtles as a result of this Project relate primarily to possible injury or disturbance (behavioral effects) from the underwater noise generated during drilling and VSP surveys, as well as other possible environmental emissions (waste materials) from the MODUs and related vessel and aircraft traffic. Any potential for Project-VC interactions is, however, likely to be highly transient and temporary for individuals, especially in consideration of the large-scale daily and seasonal fluctuations in presence within the RSA and the alternate habitats available. Mitigation measures will be applied across a number of Project components and activities will help prevent or reduce potential interactions with this VC, as described in Section 10.3.2.

15.4.3 On-Going and Future Projects and Activities and Their Effects

On-going and potential projects and activities which may affect marine mammals and sea turtles within the RSA include fisheries, general vessel traffic, and other on-going and planned offshore oil and gas exploration and production activities, as summarized in Table 15.8.

Table 15.8 Marine Mammals and Sea Turtles: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on the VC			Spatial and Temporal Considerations
	Change in Mortality / Injury Levels and Health	Change in Habitat Availability, Quality and Use	Change in Food Availability or Quality	
Hibernia Oilfield	●	●	●	• Production at these projects and associated vessel traffic occur year-round and are a continuous source of underwater sound, as well as other environmental disturbances such as waste discharges.
Terra Nova Oilfield	●	●	●	
White Rose Oilfield and Extension	●	●	●	
Hebron Oilfield	●	●	●	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	●	●	●	• The primary environmental issues related to offshore seismic activities and their effects on marine mammals and sea turtles are related to underwater noise and its potential direct and indirect effects on these species. • This can include temporary hearing impairment or permanent injury or mortality from exposure to loud underwater noise after coming into close contact with a seismic sound source, as well as possible behavioural effects (avoidance) due to sound emissions or other

Project / Activity	Potential Effects on the VC			Spatial and Temporal Considerations
	Change in Mortality / Injury Levels and Health	Change in Habitat Availability, Quality and Use	Change in Food Availability or Quality	
				disturbances, altering the presence, abundance and overall distribution of marine mammal and sea turtles and their movements, feeding and other activity. • Although the large survey areas covered by some 2D/3D offshore seismic surveys and the known propagation of noise in the marine environment can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most proposed survey activities operate for a short period of time in any one location. • Underwater noise from seismic surveys can, however, be detected at some considerable distance from the source (see Section 5.5.7).
Offshore Petroleum Exploration Activity - Drilling	●	●	●	• The underwater noise and other environmental emissions and interactions associated with offshore drilling can likewise have effects on marine mammals and sea turtles. • Drilling programs are typically relatively short-term and localized activities, which can reduce the potential for particular individuals and populations to be affected simultaneously and repeatedly by multiple projects and activities
Fishing Activity	●	●	●	• Commercial fishing activity in the region is extensive and diverse, involving a variety of participants, species, gear types, and occurs year-round. • Key issues related to this VC include the potential for collisions with individuals, gear entanglement, as well as any disturbances related to noise or other emissions. • Commercial fishing effort is mainly located in other areas off Eastern Newfoundland, and the Project Area / LSA are not key areas for fishing (Section 7.2).
Other Marine Vessel Traffic	●	●	●	• Other marine vessel traffic also takes place throughout the RSA, including cargo ships, supply vessels, cruise ships and other commercial and recreational vessels • Key issues related to this VC include the potential for collisions with individuals, as well as any disturbances related to noise or other emissions.

Project / Activity	Potential Effects on the VC			Spatial and Temporal Considerations
	Change in Mortality / Injury Levels and Health	Change in Habitat Availability, Quality and Use	Change in Food Availability or Quality	
				• Vessels are highly transitory, leading to limited potential for overlap of effects at any particular area and time
Hunting Activity	•			• Some types of marine mammals (seals) can experience change in mortality / injury levels due to hunting. • Although such hunting is restricted to nearshore areas, some species are mobile and individuals that occur in the RSA may also be at risk of mortality due to hunting.

15.4.4 Potential Cumulative Environmental Effects

As noted in the table above, other on-going and future activities that may affect marine mammals and sea turtles in the RSA include fishing activity, general vessel traffic and other offshore oil and gas exploration and production programs. Based on previous studies (see Section 10.3), most potential effects as a result of these activities occur within relatively close proximity (several kilometers) of the source, although the known propagation of underwater noise through the marine environment results in some potential for overlap and accumulation between the effects of separate activities and their disturbances. Individual marine mammals and sea turtles may also be exposed to multiple sources of underwater noise while in the RSA due to their widespread, mobile, and migratory nature, which could increase the risk of mortality or physical injury and may result in behavioural changes in individuals exposed to multiple noise sources.

Although the various oil production projects in the Jeanne d'Arc Basin off Eastern Newfoundland and their associated vessel traffic are large-scale operations that occur year-round and are a continuous source of underwater sound and other environmental disturbances, their noise levels are typically below the thresholds required for injury or mortality. Moreover, the overall distances between these operations and this Project, as well as the short-term nature of Project activities at any one location (especially, drilling and VSP) limits the potential for cumulative effects to occur through multiple and continuous or repeated disturbances to individuals. Similarly, while other oil and gas exploration (seismic and drilling) programs will undoubtedly occur within the RSA over the course of this Project, these activities are likewise limited in duration and in the geographic extent of any associated marine disturbances at any one location and time. Any avoidance of an area by marine mammals or other effects as a result of a single program (seismic or drilling) would therefore likely be localized and temporary in nature, and this will be further achieved through the required spatial separation of these activities (through EL boundaries and safety zones, as discussed previously). Other on-going and future offshore oil exploration and production projects are expected to adhere to regulated and/or industry standards and applicable best management practices to reduce their effects (and thus, contributions to cumulative effects) on marine mammals and sea turtles.

Project-related supply vessel traffic within the RSA and other vessel traffic also pose a risk of mortality or physical injury to marine mammals and sea turtles due to the increased potential for vessel strikes. Such vessel traffic is short-term and transient in nature, however, which limits the opportunity for such strikes. Project-related vessels will maintain a steady course and safe vessel speed and avoid observed concentrations of marine mammals and sea turtles whenever possible to reduce the risk of a vessel strike. Commercial fishing activities may also affect marine mammals and sea turtles through vessel strikes or possible entanglement with fishing gear, as well as by affecting fish that serve as key feed sources for these species. As indicated previously, however, most commercial fishing activity occurs well outside the boundaries of the Project Area. The short-term and localized nature of Project-related activities and the planned and required implementation of safety zones around the planned activities will limit the potential for activities and their disturbances to overlap in space and time, and thus, for cumulative effects on marine mammals and sea turtles, including through indirect effects on fish (prey) and fish habitat.

15.4.5 Species at Risk

Within the RSA there are some six species of mysticetes (baleen whales), 14 odontocetes (toothed whales), four species of phocids (seals) and two species of sea turtles that are known or likely to occur. While some of these species are migratory, others may be present in the Project Area and/or RSA year-round. Ten of these species are listed under Schedule 1 of SARA, or have been identified as species of conservation concern by COSEWIC. Detailed descriptions of species sightings in the Project Area and RSA are found in Section 6.3, which also provides a detailed overview of the various natural and anthropogenic factors and influences that have affected these species and have contributed to their current designations, and that information is therefore not repeated here.

The main potential environmental interactions between the Project, other projects and species at risk are the same as those for the marine mammals and sea turtles VC as a whole. All of these species are highly mobile, and many have broad ranges and show large movements across annual migration routes. Large seasonal and even daily fluctuations in presence and abundance within the Project Area and RSA are therefore predicted. Although the widespread and often migratory nature of some species increases the potential for individuals and populations to be affected by multiple perturbations in various locations, these mobile species have capability for avoidance. While there is some potential for overlap and interaction between the Project and other projects and activities (particularly with respect to underwater noise), effects are likely to be transient and temporary in nature without significant adverse cumulative effects on individuals or populations.

Therefore, the Project will not likely make any material or detectable contribution to potential cumulative effects on any species at risk.

15.4.6 Cumulative Effects Summary and Evaluation

Table 15.9 summarizes the results of the cumulative effects assessment for this VC. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on marine mammals and sea turtles in combination with other projects and activities that have been or will be carried out.

Table 15.9 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and On-Going Activities)	• Species that occur in the RSA that may interact with the Project include: 20 species of cetaceans, of which six are mysticetes (baleen whales), 14 are odontocetes (toothed whales); four species of phocids (seals); and two species of sea turtle. • While some of these species are migratory, others may be present in the RSA year-round. Several of these species are listed under Schedule 1 of SARA, or have been identified as species of conservation concern by COSEWIC. • A number of EBSAs, some of which represent important foraging habitat and migratory routes for marine mammals and sea turtles, intersect the RSA. There is no designated critical habitat for marine mammals or sea turtles in the Project Area or RSA.
Residual Environmental Effects of the Project	• The Project is not likely to result in significant effects on marine mammals and sea turtles. • Based on the distribution and habitat use of marine mammals and sea turtles in the Project Area and RSA and the short-term nature of most Project-related activities, confidence is high that while residual effects may adversely affect a small number of individual marine mammals or sea turtles (such as through avoidance), any such effects are unlikely to alter the long-term viability of local or regional populations. • Project activities will occur in an area where no critical habitat for species at risk has been designated, and where marine mammal and sea turtle presence is likely to be transient, with daily and seasonal fluctuations in the individuals potentially exposed.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia Oilfield	Yes: Continuous noise and other disturbances are generated by the production platform, and there is transient noise and risks of vessel strikes associated with shuttle tankers and supply vessels. However, due to the location of the project and its associated activities, it is unlikely there will be more than minor interaction with the effects of this Project.
Terra Nova Oilfield	Yes: Continuous noise and other disturbances are generated by the production platform, and there is transient noise and risks of vessel strikes associated with shuttle tankers and supply vessels. However, due to the location of the project and its associated activities, it is unlikely there will be more than minor interaction with the effects of this Project.
White Rose Oilfield and Extension	Yes: Continuous noise and other disturbances are generated by the production platform, and there is transient noise and risks of vessel strikes associated with shuttle tankers and supply vessels. However, due to the location of the project and its associated activities, it is unlikely there will be more than minor interaction with the effects of this Project.
Hebron Oilfield	Yes: Continuous noise and other disturbances are generated by the production platform, as well as transient noise and risks of vessel strikes associated with shuttle tankers and supply vessels. However, due to the location of the project and its associated activities, it is unlikely there will be more than minor interaction with the effects of this Project.

Summary of Potential Cumulative Environmental Effects	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	Yes: Underwater noise and other environmental disturbances generated by seismic surveys. Some potential for interaction, although localized and short-term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Offshore Petroleum Exploration Activity - Drilling	Yes: Underwater noise and other environmental disturbances generated by exploratory drilling. Some potential for interaction, although localized and short-term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Fishing Activity	Yes: Marine mammals and sea turtles may be affected by commercial fishing activities through vessel strikes, entanglement in fishing gear, effects on prey species, and the noise created by fishing vessels. Some potential for interaction, although these are transient activities and the available data do not indicate that the Project Area is a key fishing area. Safety zones around Project activities will limit potential for overlap, and thus, cumulative effects on this VC.
Other Marine Vessel Traffic	Yes: Underwater noise may result in changes in behaviour and increased risk of vessel strikes. Some potential for interaction, although these activities and their effects are highly localized and transient. Safety zones around Project activities will limit potential for overlap, and thus, cumulative effects on this VC.
Hunting Activity	Yes: Hunting pressure could potentially result in cumulative changes in mortality/injury to harvested seal species.
Cumulative Effects Summary	The Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

15.5 Special Areas

Special areas of various types are located within and offshore Eastern Newfoundland, including coastal and marine areas that have been designated as protected through regulatory processes or formally identified through relevant initiatives as being special or sensitive areas. These are described and mapped in some detail in Section 6.4.

15.5.1 Past and On-going Effects (Baseline)

The current environmental conditions within the existing, identified special areas off Eastern Newfoundland reflect the occurrence and environmental consequences of past and ongoing anthropogenic activities and natural processes within and beyond their boundaries, as well as those that may have affected the larger natural and socioeconomic features and processes that characterize and influence them. Special areas are identified and designated in order to recognize their importance and/or protect particularly important or sensitive environmental components. In certain cases, this is based on the objective of conserving the presently pristine nature of these areas or to otherwise ensure that important ecological processes and features remain intact (eg, EBSAs). In other cases, their designation is intended to help prevent further damage to already affected and sensitive environmental features and components (eg, FCAs).

15.5.2 Potential Project-Related Contributions to Cumulative Effects

Many of the identified special areas in Eastern Newfoundland are in nearshore and onshore areas and thus would not have direct contact with the Project-related activities. These include provincial (ecological reserves, parks and protected areas and historic sites), national (MPAs, fisheries closures within the EEZ, MBSs, parks and historic sites) and international (IBAs and WHSs) designations, none of which will be directly affected by the Project.

Although the Project Area and planned support vessel and aircraft traffic routes overlap with a number of special areas off Eastern Newfoundland, there are no prohibitions of the types of activities being planned as part of this Project. Given the overall nature of the planned Project activities, the overall and defining physical, biological and socioeconomic environments within these areas will not be adversely affected by the Project. Again, many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized and of a short-term nature at any particular location, and the implementation of the various environmental protection measures and procedures outlined throughout this EIS will serve to further address any direct (or indirect) potential effects on the existing environmental characteristics and conditions of these special areas.

15.5.3 On-Going and Future Projects and Activities and Their Effects

On-going and other future projects and activities that may affect special areas include fisheries, general vessel traffic, and other current and planned offshore oil and gas production and exploration activities, as listed in Table 15.10.

Table 15.10 Special Areas: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on the VC	Spatial and Temporal Considerations
Hibernia Oilfield	• Project-related environmental emissions, disturbances and interactions may affect the existing natural or human environments in the area. • This in turn may affect the key environmental characteristics and processes that define and distinguish these areas, and thus, affect their overall and underlying characteristics, integrity and value.	• The Hibernia Oilfield has a well-defined footprint, which does not overlap with any existing special areas.
Terra Nova Oilfield		• The Terra Nova Oilfield has a well-defined footprint, which does not overlap with any existing special areas.
White Rose Oilfield and Extension		• The White Rose Project has a well-defined footprint, which does not overlap with any existing special areas.
Hebron Oilfield		• The Hebron Oilfield has a well-defined footprint, which does not overlap with any existing special areas.
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities		• Although the large survey areas covered by some types of offshore seismic surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most proposed survey activities operate for a very short period of time in any one location, resulting in a short-term

Project / Activity	Potential Effects on the VC	Spatial and Temporal Considerations
		disturbance within a relatively limited zone of influence overall.
Offshore Petroleum Exploration Activity - Drilling		• Drilling and other types of exploration activities are typically relatively short-term and localized activities. • This can reduce the potential for particular environmental features and areas to be affected simultaneously and repeatedly by multiple projects and activities
Fishing Activity		• Commercial fishing activity in the region is extensive and diverse, involving a variety of participants, species, gear types, and occurs year round. • Fishing activity takes place with special areas (such as EBSAs) unless otherwise prohibited (eg, bottom fishing activities within Fisheries Closure Areas, see below)
Other Marine Vessel Traffic		• Marine vessel traffic occurs in the offshore year-round • Vessels are highly transitory, minimizing effects in any particular location and time
Hunting Activity		• Some types of marine birds and (specifically, murres and waterfowl) and mammals (seals) , which are relevant to special areas designation and condition, can experience change in mortality / injury levels due to hunting.

15.5.4 Potential Cumulative Environmental Effects

The Project Area overlaps with small portions of three NAFO Fishery Sponge, Coral and Seapen Closure Areas, for which there are no associated prohibitions of marine activities such as those being proposed as part of this Project. Only one of these NAFO Closures Areas overlaps with any part of the ELs themselves, within which any Project-related drilling activity must and will take place. In addition, a number of special areas (VMEs, NAFO FCAs, and an EBSA) are located within the general vicinity of (with 50 km of) the LSA. The identified general support vessel / aircraft traffic route from Eastern Newfoundland to the Project Area does, given its possible commencement at an existing onshore port site in this region, occur within one kilometer of several coastal special areas in Eastern Newfoundland (a National Historic Site and an IBA), and within 5 km of several others, as well as intersecting with one EBSA offshore.

These special areas do not overlap with any of the on-going oil and gas production projects (Hibernia, Terra Nova, White Rose or Hebron) off Eastern Newfoundland. They do or may, however, interact spatially with planned or potential oil and gas exploration activities in the region, including offshore seismic surveys and drilling. Although the specific location and timing of other offshore oil and gas exploration activities in the region over the duration of this Project is not and cannot be known and defined, most such survey activities result in a short-term disturbance within a relatively limited zone of

influence with applicable mitigations implemented to avoid or reduce their potential environmental consequences. This reduces the potential for particular areas and their environmental characteristics to be affected simultaneously and repeatedly by multiple projects and activities, resulting in the accumulation of environmental effects over time and space. In addition, while other general marine traffic occurs throughout the Newfoundland offshore and is likely to intersect with any special areas that overlap the Project Area, vessel traffic is intermittent and transient at any one location and time, with limited contributions to cumulative effects on any particular area.

Although commercial fishing activity in the region is extensive and diverse, it is focused in certain parts of the RSA. As described previously, the available fisheries geospatial data does not indicate that the Project Area itself is a core area for commercial fishing (Section 7.2). While commercial fishing results in direct loss (mortality) of fish and introduces other disturbances into the marine environment, such as waste materials and light, its occurrence at any particular location and time is likewise limited, and these activities have relatively small footprints and are of short duration. Overall, fishing activity is subject to applicable management processes and regulations, and it is therefore not likely to affect the overall environmental integrity and viability of these special areas. Bottom contact fishing is prohibited within NAFO FCAs, and so these special areas will not be directly affected by such fishing activity in combination with Project activities. Given the minor, localized and short-term nature of any Project-related disturbances within these areas, and the determination that the Project will not have a significant effect on these special areas, cumulative effects are not anticipated. In addition, bird hunting activity does not occur within these offshore areas, and in any event does not target many of the species that are relevant to the identification of these special areas.

15.5.5 Cumulative Effects Summary and Evaluation

Table 15.11 summarizes the results of the cumulative effects assessment for special areas. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on special areas in combination with other projects and activities that have been or will be carried out.

Potential cumulative effects on biological / ecological components and human use related to special areas have also been addressed in the other VCs considered in this chapter. Implementation of the various environmental mitigation procedures outlined throughout this EIS, including those which are designed to avoid or reduce Project-related discharges and/or disturbances and their associated environmental effects, will also serve to help address any potential Project-related contributions to cumulative effects on special areas.

Table 15.11 Summary of Potential Cumulative Environmental Effects: Special Areas

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and On-Going Activities)	• Various types of special areas are located within the LSA and RSA, including coastal and marine areas protected through legislation or formally identified as being special or sensitive. • Many of these special areas are in nearshore and onshore areas. These include: provincial ecological reserves, parks and protected areas and historic sites; national MPAs, fisheries closures within the EEZ, MBSs, parks and historic sites, as well as international designations such as IBAs and WHSs.

Summary of Potential Cumulative Environmental Effects	
	• Several types of special areas are located in the LSA within the offshore environment.
Residual Environmental Effects of the Project	• Although the Project Area overlaps with a number of special areas off Eastern Newfoundland, there are no prohibitions of the types of activities being planned as part of this Project. • Given the overall nature, scale and duration of the planned Project activities, the overall and defining biophysical and socioeconomic environments within these areas will not be adversely affected by it.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia Oilfield	No: There are no special areas that overlap with or are in close proximity to this development (and thus is associated environmental emissions), and it is far away from any such areas that may be affected by this Project
Terra Nova Oilfield	No: There are no special areas that overlap with or are in close proximity to this development (and thus is associated environmental emissions), and it is far away from any such areas that may be affected by this Project.
White Rose Oilfield and Extension	No: There are no special areas that overlap with this development, and it is far away from any such areas that may be affected by this Project
Hebron Oilfield	No: There are no special areas that overlap with or are in close proximity to this development (and thus is associated environmental emissions), and it is far away from any such areas that may be affected by this Project.
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	Yes: Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigations, will minimize the potential for these activities and this Project to detectably and simultaneously affect the same special areas.
Offshore Petroleum Exploration Activity - Drilling	Yes: Some potential for interaction, although localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigations, will minimize the potential for these activities and this Project to detectably and simultaneously affect the same special areas.
Fishing Activity	Yes: Some potential for interaction, although these are transient activities and the available data do not indicate that the Project Area is a key fishing area. Localized and short term nature of these activities and their effects, along with planned and required separation measures and other mitigations, will minimize the potential for these activities and this Project to detectably and simultaneously affect the same special areas.
Other Marine Vessel Traffic	Yes: Some potential for interaction, although these are transient and not particularly disruptive activities. This, along with planned and required separation measures(safety zones) and other mitigations, will minimize the potential for these activities and this Project to detectably and simultaneously affect the same special areas.
Hunting Activity	No: Given their locations far offshore, there is no known hunting activity within special areas that will overlap with Project activities.

Summary of Potential Cumulative Environmental Effects	
Cumulative Effects Summary	The Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

15.6 Indigenous Peoples

This EIS has described identified Indigenous communities and their activities and interests in Newfoundland and Labrador, the Maritime Provinces (NS, NB, PEI) and Quebec (Section 7.4) and assessed and evaluated any potential effects of the Project on these communities (Chapter 12). The environmental effects assessment for this VC focuses on and addresses each of the associated factors specified in and required under CEAA 2012, including: 1) the current use of lands and resources for traditional purposes, 2) human health, 3) socio-economic conditions, 4) physical and cultural heritage, and 5) structures, sites or things of historical, archaeological, paleontological or architectural significance to groups, as well as any other factors as relevant.

15.6.1 Past and On-going Effects (Baseline)

Other past and on-going projects and activities in Eastern Canada have, to varying degrees, interacted with and affected Indigenous communities and activities, depending on their location, nature and scale in relation to the communities, activities and other components and interests of individual Indigenous groups. While it is not practical in this EIS to attempt to identify and describe all past and ongoing development projects and other processes and activities that have influenced and otherwise affected Indigenous peoples throughout Eastern Canada over time, an overview of current socioeconomic characteristics and condition of Indigenous communities, which inherently reflects any such past and on-going effects, was presented in Section 7.4. This has included, where possible and applicable, an identification of where and how certain socioeconomic components, such as traditional land use patterns for example, may have been influenced by previous and on-going development activities and other factors.

15.6.2 Potential Project-Related Contributions to Cumulative Effects

Given the nature, location and timing of the various planned activities and associated Project-induced changes to the environment likely to occur as a result of this Project, it is not expected to have any adverse effects on Indigenous Peoples. As most Project-related activities will take place in the offshore marine environment, over 400 km from land and thus from any community (Indigenous or otherwise) and because any associated environmental emissions and other disturbances are expected to be quite localized and short-term in nature, they are unlikely to extend to or in any way affect the health (physical or social) and well-being or other socioeconomic conditions of any Indigenous community. There are no documented food, social or ceremonial licenses in or near the Project Area, nor are any groups known to undertake current land and resource use activities for traditional purposes off Eastern Newfoundland. There are also no other known aspects of the physical and cultural heritage of these groups located in proximity to, or which may otherwise be affected by, the Project.

The environmental effects analysis also indicates that very few of the marine associated resources (species) that are known to be used by Indigenous groups (such as Atlantic salmon) migrate through the Project Area / LSA and are thus likely to be affected by Project activities and disturbances, and the

implementation of the various environmental mitigation measures and procedures outlined throughout this EIS will serve to further address any direct or indirect potential effects on these resources. There is therefore no potential for the availability or quality of any resources that are currently used for traditional purposes by Indigenous groups to be reduced or negatively affected in other ways as a result of the Project, especially to a nature and to a degree that would alter the nature, location, timing, intensity or value of these activities or the health or heritage of any Indigenous peoples.

No residual effects (direct or indirect) on the current use of lands and resources for traditional purposes by any group are therefore anticipated as a result of this Project. It will therefore not contribute to any cumulative effects on Indigenous Peoples

15.6.3 Cumulative Effects Summary and Evaluation

As a result of the above, the Project will therefore not result in any residual environmental effects on Indigenous Communities and Activities, and will therefore not result in or contribute to any cumulative effects to this VC (Table 15.12).

Table 15.12 Summary of Potential Cumulative Environmental Effects: Indigenous Peoples

VC Existing Condition (Past and On-Going Activities)	• Indigenous groups reside in Newfoundland and Labrador, Nova Scotia, New Brunswick, PEI, and Quebec • Other past and on-going projects and activities have, to varying degrees, interacted with and affected Indigenous people, communities and their activities or other interests.
Residual Environmental Effects of the Project	• The Project will not result in any residual environmental effects on Indigenous Peoples, and will therefore not result in or contribute to any cumulative effects to this VC.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia Oilfield	No: The Project will not result in any residual environmental effects on Indigenous Peoples, and will therefore not result in or contribute to any cumulative effects to this VC.
Terra Nova Oilfield	
White Rose Oilfield and Extension	
Hebron Oilfield	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities, and Drilling	
Fishing Activity	
Other Marine Vessel Traffic	
Hunting Activity	
Cumulative Effects Summary	The Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

15.7 Fisheries and Other Ocean Uses

15.7.1 Past and On-going Effects (Baseline)

A variety of marine activities occur within and throughout the RSA and in the larger Eastern Newfoundland Offshore Area. Commercial fisheries are extensive and diverse, being undertaken by fishing interests from Newfoundland and Labrador, elsewhere in Canada and various other countries, and involving a range of species and gear types. Other marine components and activities in the region include those associated with the use of the marine environment for shipping and transportation, petroleum exploration and production, military activities, fisheries and other ocean research, infrastructure (such as marine cables), marine based tourism and recreation, and others.

Marine fisheries (commercial domestic, commercial foreign, aquaculture and recreational) conducted off Eastern Newfoundland are important for their economic and cultural value. Based on the existing and available information provided in Section 7.2, the primary commercial fishing areas in recent years are concentrated along the continental shelf and in inshore waters off the coast of Eastern Newfoundland. The Project Area and LSA for this VC are therefore located well outside of the key areas for fishing, as reflected in the domestic fishing activity maps presented in Section 7.2.6 (which are based on DFO fisheries information for the 2010-2015 period). The Project Area does, however, overlap with the identified NAFO “fisheries footprint” (Figure 15.1), although it does not overlap with the identified highest intensity fishing areas within that footprint (Section 7.2.9). The main species harvested in the RSA in recent decades have been Northern shrimp and snow crab. While commercial fishing activity is carried out throughout the year, the most active time for harvesting is during the summer period.

As also described in Section 7.2, commercial fisheries off Eastern Newfoundland and elsewhere have seen important changes over the past decades, with the collapse in groundfish stocks and associated moratoria in the early 1990s and resulting shift in emphasis towards shellfish species. Recent consultations related to Newfoundland and Labrador fisheries have noted that continuing changes within the marine environment are affecting the availability of some key species, a recent example of which is the closure of the Northern shrimp fishery in Divisions 3L and 3M, and the increasingly fragile status of this species to the north. As the marine environment continues to warm, fishers expect that they will be able to fish more for groundfish, as in pre-moratorium times, and many have kept their groundfish licences in anticipation of this trend in the future (Amec 2014). Similarly, extended warm water periods in the RSA may increase the prevalence of high-value large pelagic species (swordfish and tunas). Fishers have stated that it is therefore important to consider not only what the fishery looks like now, but how it may be in the future, such as if a directed fishery for cod were to resume there might be an increased use of other gear types (Amec 2014).

15.7.2 Potential Project-Related Contributions to Cumulative Effects

Although various Project components and activities, including the associated safety zones around the active MODUs, will temporarily reduce access for fishing and other activities in certain areas, any such disturbances will be localized, short term, and reversible once Project activity ceases at that location. While this will temporarily prevent harvesters from accessing those grounds, and may require some diversion around them, the Project is unlikely to have an effect on the overall effectiveness, efficiency or value of any domestic or foreign fisheries, particularly considering the past record of fishing activity within these ELs. The Project Area and LSA do not contain any known, particularly unique fishing

grounds or concentrated fishing effort or other marine uses that occur exclusively within these areas themselves, nor is it likely to represent a substantial portion of the overall areas typically used. The early and on-going communication of these access restrictions and continued consultations and cooperation with the fishing industry will help to ensure that Project operations avoid or have minimal effects on commercial fish harvesting operations. The potential for temporary loss of access to fishing grounds because of the Project is unlikely to have a measurable effect on the overall distribution, intensity, efficiency or value of fishing activities and other marine activities in the region. Although an unlikely occurrence, damage to gear, vessels or other marine assets would also be managed through applicable compensation policies and procedures.

As most planned Project activities will take place over 400 km offshore, and the limited amount of vessel activity that will or may take place in coastal locations (such as crew changes or re-supply) will occur at existing and established commercial ports, the Project is not expected to interact with, or otherwise adversely affect, other human activities that occur on land or near shore, including relevant commercial or recreational activities and other pursuits. In addition, the Project is also not expected to result in significant adverse environmental effects upon marine fish or their habitats. Any disturbance to marine biota will be localized and of short-term duration at any one location. It is therefore unlikely that any individuals will be displaced from key habitats or usage (harvesting) areas for extended periods, or be otherwise affected or disrupted in a manner that causes effects on the overall availability or quality of any marine resource.

15.7.3 On-Going and Future Projects and Activities and Their Effects

Fisheries and other human activities in the marine environment may be affected both individually and collectively by offshore oil and gas exploration and production activities, general marine traffic, and other activities and associated disturbances (Table 15.13). Each of these may individually result in direct disturbance to such activity, damage to equipment, and effects on marine resources or other disturbances, and these effects may accumulate or interact over time on a regional scale to potentially result in cumulative environmental effects.

The dynamic nature of fishing and other marine based activity throughout the region (in terms of locations, seasons, gear types, and key species) makes it difficult to predict specific areas and times from year-to-year, and thus, the potential for interactions between separate projects, activities and their effects. At the same time, the relatively localized nature of any such potential disturbances from individual projects and activities, coupled with the overall size of the offshore area involved, limits the potential for particular users to be affected in a repeated and sustained manner.

Table 15.13 Fisheries and Other Ocean Uses: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on the VC			Spatial and Temporal Considerations
	Direct interference with fishing or exclusion from established fishing grounds	Damage to fishing gear or vessels	Decreases in the abundance, distribution and actual or perceived quality of fisheries resources	
Hibernia Oilfield	●	●	●	• Operations at these projects and associated vessel traffic occur year-round. • These projects are a continuous presence in the marine environment, with associated exclusions of other marine activities within their individual safety zones, as well as serving as a source of other environmental disturbances (such as waste discharges).
Terra Nova Oilfield	●	●	●	
White Rose Oilfield and Extension	●	●	●	
Hebron Oilfield	●	●	●	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	●	●	●	• Seismic surveys can cover large overall areas, but activity (and associated interactions) at any one location is very localized, short-term and transient in nature. • Agreed communication and coordination procedures between the offshore oil and gas industry and fishers help to limit the potential for adverse interactions.
Offshore Petroleum Exploration Activity - Drilling	●	●	●	• Exploration drilling programs occur in localized areas and are short-term in nature. • These projects result in localized and temporary exclusions of other marine activities within their individual safety zones, as well as serving as a source of other environmental disturbances (such as waste discharges) and associated effects.
Fishing Activity	●	●	●	• Although this activity is part of the VC itself, individual fishing enterprises may affect and interfere with each other (through competition for fishing areas and resources, for example).
Other Marine Vessel Traffic	●	●		• Vessel movements are transitory with limited environmental effects, limiting potential effects in any particular location and time. These activities are subject to applicable regulations regarding other marine activities.

Project / Activity	Potential Effects on the VC			Spatial and Temporal Considerations
	Direct interference with fishing or exclusion from established fishing grounds	Damage to fishing gear or vessels	Decreases in the abundance, distribution and actual or perceived quality of fisheries resources	
Hunting Activity				• Intermittent (and primarily coastal) activities with limited potential for interaction with other ocean uses.

15.7.4 Potential Cumulative Environmental Effects

Oil and gas production projects off Eastern Newfoundland include the three currently producing fields (Hibernia, Terra Nova, White Rose), and the newest field Hebron which began production in November 2017. These operations have established safety zones around them, which restrict access to defined areas for fishers and other ocean uses, and which are continuous and long-term in nature given the operational lifespans of these developments. Although the lengthy temporal scope of these operations and associated exclusions creates the potential for interactions with commercial fishers and other ocean uses, some of these projects have been operating since the 1990s and are thus an established and known part of the seascape offshore Newfoundland and Labrador. Safety zones from these fields individually and collectively occupy a relatively small footprint in comparison to available fishing areas off Eastern Newfoundland. In addition, the overall distances between these projects and any (temporary) safety zones that will be established in ELs 1144 and 1150 as a result of this Project limits the potential for individual fishers or other users to be affected concurrently by multiple projects.

The Eastern Newfoundland Offshore Area is also subject to ongoing and planned oil and gas exploration activities. This includes exploration drilling and seismic survey activities that have either been approved, or which may be approved and implemented within the timeframe of the Project. Drilling installations establish safety zones during project activities, which temporarily restrict access to defined areas for commercial fishing activity and other ocean uses. The potential exists for multiple exploration operations to occur within parts of the RSA at a given time during the life of this Project. The implementation of multiple safety zones, depending on their overall sizes and proximity to one another, could result in cumulative effects to individual fishing enterprises. However, due to the short-term and localized nature of these activities, and the implementation of communication procedures and other mitigation measures as outlined above it is not anticipated that these exploration projects will individually or collectively result in adverse environmental effects on fishers or other ocean activities. In addition, as an EL gives the licence holder the exclusive right to drill within its boundaries over its term, the regulatory process itself

helps to ensure that exploration drilling programs by multiple operators remain somewhat separated in space and time.

In terms of offshore seismic surveys, the often spatially extensive nature of these activities increases the potential for fishing enterprises and other pursuits to be affected by multiple projects and activities in a region. However, most proposed seismic survey activities operate for a very short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. As part of the planning and implementation of such survey activities, operators typically communicate and coordinate with relevant marine users and other stakeholders, including other oil and gas exploration companies operating in the area, to plan and coordinate activities in an effort to ensure that appropriate spatial and temporal separation is maintained for safety, technical (data quality) and environmental reasons. Again the required safety zone around Project-related drilling activities within ELs 1144 and 1150 will help to ensure this geographic separation between activities and potential effects.

Marine vessel traffic is also common in these offshore areas, although inherently transient in nature with limited disturbances to other ocean uses, and is likewise required to remain specified distances from other marine activities, including active offshore exploration drilling and seismic programs in the region.

15.7.5 Cumulative Effects Summary and Evaluation

Table 15.14 summarizes the results of the cumulative effects assessment for this VC. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on fisheries and other ocean uses in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any cumulative effects on this VC within the overall RSA will be low, and will not likely be perceptible.

Table 15.14 Summary of Potential Cumulative Environmental Effects: Fisheries and Other Ocean Uses

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and On-Going Activities)	• Commercial fishing and other ocean activity occurs throughout the Project Area, RSA and elsewhere off Eastern Newfoundland. • These fisheries have seen important changes over the past decades, with the collapse in groundfish stocks and associated moratoria in the early 1990s and resulting shift in fishing towards shellfish species such as crab and shrimp. • Future changes in the natural environment and human influences may see further evolution in the nature of these fisheries, including the key species of focus. • Fisheries and other human activities in the marine environment may be affected both individually and collectively by offshore oil and gas exploration and production activities, general marine traffic and other activities and their associated disturbances
Residual Environmental Effects of the Project	• Although Project components and activities, including the associated safety zones, will temporarily reduce access for fishing and other activities in certain areas, any such disturbances will be localized, short term, and reversible once Project activity ceases at a particular location.

Summary of Potential Cumulative Environmental Effects	
	• These effects will be further mitigated through good communication and cooperation between industries, with fishing gear damage compensation initiatives being implemented as required. • This, along with the relatively localized and in most cases short-term duration of these disruptions, and the amount of alternative areas available, will mean that significant adverse environmental effects are unlikely.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia Oilfield	No: These operations have established safety zones which restrict access to defined areas for fishers and other ocean uses. These are continuous and long-term in nature, but are an established part of the seascape offshore Newfoundland and Labrador. The overall distances between these projects and any (temporary) disturbances as a result of this Project limits the potential for cumulative effects to occur
Terra Nova Oilfield	
White Rose Oilfield and Extension	
Hebron Oilfield	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	Yes: Some potential for interaction, although localized and short term nature of these activities and their effects, along with required separation measures and other mitigations, will minimize potential for interaction.
Offshore Petroleum Exploration Activity - Drilling	Yes: Some potential for interaction, although localized and short term nature of these activities and their effects, along with required separation measures and other mitigations, will minimize potential for interaction.
Fishing Activity	n/a
Other Marine Vessel Traffic	Yes: Vessel movements are highly transitory with limited disturbance to other ocean uses. These activities are subject to applicable regulations regarding other marine activities.
Hunting Activity	No: Intermittent (and primarily coastal) activities with limited potential for interaction with other ocean uses.
Cumulative Effects Summary	The Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

15.8 Atmospheric Environment

The atmospheric environment includes various components of the physical environment, including air quality and greenhouse gases (GHGs).

15.8.1 Past and On-going Effects (Baseline)

As described in Section 5.4, existing ambient air quality within and around the Project Area and the LSA for this VC can be generally categorized as very good. It is, however, likely occasionally and locally influenced by exhaust emissions from marine vessel and aircraft traffic and from the operations of the existing oil production platforms (Hibernia, White Rose, Terra Nova, and Hebron). Although there are no air quality monitoring data available for the Project Area itself, an overview of the air emissions reported from the operation of Hibernia, White Rose and Terra Nova for the 2015 reporting year are provided in Section 5.4.

15.8.2 Potential Project-Related Contributions to Cumulative Effects

As described in Section 2.9.1, atmospheric emissions resulting from planned Project activities will include exhaust from the MODU(s), supply vessels and aircraft and their associated equipment (such as on-board power generators), as well as emissions from the storage and flaring of hydrocarbons associated with well testing (if and as required). Anticipated emissions from these sources include products of fuel combustion, mainly criteria air contaminants (CACs, particulate matter, carbon monoxide [CO], sulphur oxides [SOx], nitrogen oxides [NOx]) and GHGs. Three classes of particulates were considered: TPM, fine particulate matter less than 10 microns (PM_{10}) and fine particulate matter less than 2.5 microns ($PM_{2.5}$). Detailed calculations of the various air emissions that will be associated with the Project, by key component and activity, is provided in Chapter 14.

The environmental effects assessment for this VC (Chapter 14) indicated that atmospheric emissions from planned Project activities will produce a localized, transient effect on air quality. Also, since the predicted GHG emissions from the Project are low and not significant in comparison to GHG targets, the Project will have virtually no effect on current estimates of future global climate change. The Project is not likely to result in significant adverse environmental effects on the atmospheric environment.

15.8.3 On-Going and Future Projects and Activities and Their Effects

In terms of potential cumulative environmental effects, these atmospheric emissions theoretically have the potential to interact and accumulate with the emissions from other sources in the RSA and beyond, including other marine vessel traffic (including fishing vessels) in the area, other exploration activities (seismic, drilling, and others) and the operation of existing offshore oil production operations in the Jeanne d'Arc Basin (see Section 5.4 for an overview of air emissions from these facilities and their effects on ambient air quality in the region). In terms of other exploration activities, fishing, and other marine vessel traffic, the short-term and transient nature of these activities and thus their air emissions, as well as the low levels of air emissions resulting from these activities, limits the potential for direct interaction with air emissions from this Project. Similarly, in terms of the existing production projects offshore Eastern Newfoundland, the locations of these sources with respect to the Project makes an interaction unlikely, especially one with the potential to result in a detectable (and especially, significant) effects. This is supported by results presented in the 2013 ESRF Air Emissions Study – Effects of Offshore Oil and Gas Production on Air Quality in Canada's East Coast Offshore Areas (Stantec 2013), which concluded that air emission concentrations (in this case NO_X) generally meet onshore ambient air quality regulations within 500 m of the emitting platform.

Table 15.15 Atmospheric Environment: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on the VC		Spatial and Temporal Considerations
	Change in Air Quality	Change in GHG Emissions	
Hibernia Oilfield	●	●	• Operations at these projects and associated vessel and aircraft traffic occur year-round and are a continuous source of emissions to the atmospheric environment.
Terra Nova Oilfield	●	●	
White Rose Oilfield and Extension	●	●	
Hebron Oilfield	●	●	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities	●	●	• These activities are an intermittent and localized source of emissions to the atmospheric environment. • Although the large survey areas covered by some 2D/3D offshore seismic surveys can increase the potential for spatial interactions between their effects and those of other projects and activities, most such survey activities operate for a short period of time in any one location.
Offshore Petroleum Exploration Activity - Drilling	●	●	• These activities are likewise an intermittent and localized source of emissions to the atmospheric environment, similar to those predicted for this Project (Chapter 14).
Fishing Activity	●	●	• Commercial fishing activity is an intermittent and localized source of emissions to the atmospheric environment (vessel engines). Most fishing activities operate for a short period of time in any one location.
Other Marine Vessel Traffic	●	●	• These activities also occur throughout the RSA and are an intermittent and localized source of emissions to the atmospheric environment (vessel engines).
Hunting Activity	●	●	• These activities are an intermittent and localized (but negligible) source of emissions to the atmospheric environment

15.8.4 Potential Cumulative Environmental Effects

The above summarized analysis of the anticipated types and levels of Project-related air emissions and their contribution to regional ambient air quality and GHG levels has shown that the Project will make a negligible contribution to same, and therefore will not result in or contribute to detectable effects on the atmospheric environment overall.

15.8.5 Cumulative Effects Summary and Evaluation

As noted above, the Project will not result in detectable effects on regional air quality, nor will its emissions likely interact with those of other projects and activities. The Project is not likely to result in

significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

Table 15.16 Summary of Potential Cumulative Environmental Effects: Atmospheric Environment

VC Existing Condition (Past and On-Going Activities)	• Existing ambient air quality can be generally categorized as good, but is likely occasionally and locally influenced by exhaust emissions from marine vessel and aircraft traffic and other sources.
Residual Environmental Effects of the Project	• Atmospheric emissions from planned Project activities will produce a localized, transient effect on air quality. Due to the distance from shore air quality effects on onshore areas and receptors are very unlikely. • Since the predicted GHG emissions from the Project are low and not significant in comparison to GHG targets, the Project will have virtually no effect on current estimates of future global climate change. • The Project is not likely to result in significant adverse environmental effects on this VC.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia Oilfield	No: Due to the distances of these sources with respect to the Project, an interaction with the potential to result in a detectable effect is not likely. This is supported by results presented in the 2013 ESRF Air Emissions Study – Effects of Offshore Oil and Gas Production on Air Quality in Canada's East Coast Offshore Areas (Stantec 2013), which concluded that air emission concentrations (in this case NO_x) generally meet onshore ambient air quality regulations within 500 m of the emitting platform.
Terra Nova Oilfield	
White Rose Oilfield and Extension	
Hebron Oilfield	
Offshore Petroleum Exploration – Seismic / Geophysical and Other Exploration Activities, and Drilling	Yes: Some potential for interaction, although the localized and short term nature of these activities and their atmospheric emission levels, along with required separation measures and other mitigations, will minimize potential for interaction.
Fishing Activity	Yes: Some potential for interaction, although these are transient activities and the available data do not indicate that the Project Area is a key fishing area. The localized and short term nature of these activities and their atmospheric emission levels, along with required separation measures and other mitigations, will minimize potential for interaction.
Other Marine Vessel Traffic	Yes: Some potential for interaction, although the localized and short term nature of these activities and their atmospheric emission levels, along with required separation measures and other mitigations, will minimize potential for interaction.
Hunting Activity	Yes: Some potential for interaction, although the localized and short term nature of these activities and their (very low) atmospheric emission levels, along with required separation measures and other mitigations, will minimize potential for interaction.
Cumulative Effects Summary	The Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out.

15.9 Monitoring and Follow-up

Any monitoring and/or follow-up programs that have been identified and described for particular VCs as part of the Project-specific environmental effects assessment (Chapters 8 to 14) would be relevant to cumulative effects, in that they are relevant to the Project's potential contribution to cumulative effects in the region. No additional or revised monitoring or follow-up is required or proposed related specifically to potential cumulative environmental effects.

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16 ACCIDENTAL EVENTS

During an offshore exploration drilling project, an accidental event or malfunction is an unlikely, although potential, occurrence. Environmental incidents that may be associated with offshore drilling activities include potential subsurface blowouts, as well as spills of hydrocarbons or other substances from a MODU or associated supply and support vessel activities. These events may vary considerably in terms of their nature, scale, duration and potential environmental consequences. This chapter describes possible accidental events and malfunctions and assesses potential effects that could result for each identified VC. The assessment includes a detailed description of the modelling undertaken to better understand the potential effects.

This chapter has been organized to provide an overview of the Nexen management systems and governance frameworks that systematically manage the core aspects of Nexen's business through consistently applied standards, processes, procedures, and assurance. It discusses Nexen's prevention and response practices and provides details around specific potential accidental event scenarios. Following the description and rationale for selection of the assessed scenarios, this chapter provides an overview of the associated risk and probabilities for each scenario. It is important to note that the modelled and assessed scenarios in this chapter are unmitigated events to provide a conservative basis for the environmental effects assessment. However, the effects assessment considered in this chapter does consider the use of mitigation measures when determining residual effects.

16.1 Spill Prevention and Response

As described previously in Section 1.1, Health, Safety, Environment and Social Responsibility (HSE&SR) are core values at Nexen. The success of every activity undertaken by the company is measured on its ability to execute the work in a safe and environmentally responsible manner.

16.1.1 Accident Prevention

Nexen's first priority is to prevent incidents from occurring. Nexen achieves this by providing a high degree of stewardship, risk assessment and scrutiny of potential hazards through its Leadership and Safety culture, its personnel competency and training programs, the Nexen Management System, Nexen's robust Process Safety Management (PSM) system, and the Well Delivery Process (WDP).

Process Safety is a disciplined framework for managing the integrity of operating systems and processes, handling hazardous substances by applying good design principles, engineering, and operating practices. It deals with the prevention and control of incidents that have the potential to release hazardous materials or energy. Such incidents can cause toxic effects, fire, or explosion and could ultimately result in injuries, environmental effects, property damage, and/or lost production.

The Nexen hazard identification and risk assessment processes form a key component of PSM and allow Nexen to identify hazards and potential incidents, develop preventative barriers and recovery measures, identify the necessary training and conduct response exercises to mitigate potential risk.

16.1.1.1 Leadership and Safety Culture

"Safety First" is a Nexen core cultural belief and is a key component of the Nexen commitment to create a safe work environment for our personnel (employees and contractors). Utilizing clear direction and instruction about occupational health and safety, Nexen applies job performance standards and workplace rules in a fair and consistent manner to all Nexen and contractor personnel. The Nexen Stop Work Authority is an integral part of the Safety First culture and is vital to ensuring the safety and well-being of our personnel where every individual is accountable to protect the safety and well-being of themselves, co-workers and the communities and environment in which they work. All Nexen personnel, no matter at what level of the organization, have the authority to stop work if they determine it to be unsafe.

16.1.1.2 Competency and Training

The Nexen Standard for Assuring Competency and Verifying Safety Critical Positions sets out corporate competency requirements. The Standard provides the basis for required functional training and competency management across the Nexen organization for safety critical roles.

The Nexen global drilling and completions team has a robust competency management program that aligns with the Standard. The foundation for the program is job position profile maps that identify required critical competencies. This includes regulatory, technical, and business requirements, and notably HSE/PSM training and any advanced certifications (e.g., advanced well control certification for those involved in the planning and execution of wells). All Nexen drilling and completions personnel undergo a formal assessment based on critical competency criteria.

16.1.2 Process Safety Management

In order to protect the public, our workers and the environment, process safety hazards are minimized and controlled through the diligent application of systematic PSM practices and procedures as part of a PSM Framework. The Nexen PSM Framework requires that the organization identify and manage risks associated with its operations. In order to comply with this requirement, Nexen is committed to design, construct, commission, inspect, and maintain all physical assets and aspects associated with well construction, completion, intervention, and abandonment, so as to prevent, mitigate, respond and restore to a safe situation should any process safety event occur.

Nexen's PSM Framework is based on the Center for Chemical Process Safety (CCPS) four Pillar, 20 Element Framework which is well recognized within the oil & gas industry. The four pillars (see Figure 16.1 below) include:

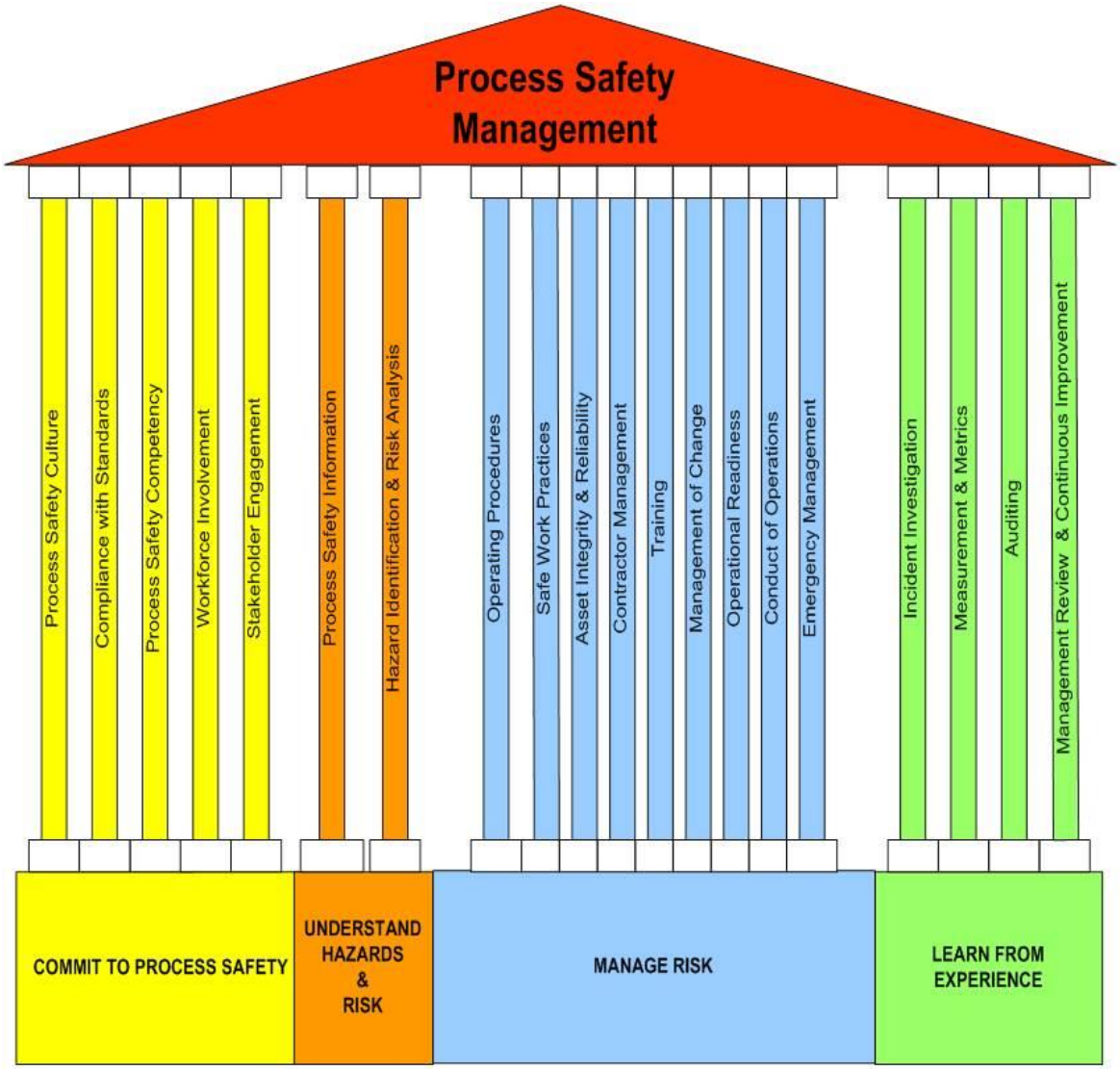
- *Commit to Process Safety*: Employees and contractors of companies with core values of safety will tend to do the right things, in the right ways at the right time.

- *Understand Hazards and Risks*: Understanding potential hazards and associated risk is the foundation of a risk based approach.

- *Manage Risk*: Management of risk is the ongoing execution of risk based process safety activities.

- *Learn from Experience*: Learning from experience furnishes the opportunities for improvement. Metrics including leading indicators provide a direct feedback.

Figure 16.1 Nexen PSM Framework



16.1.2.1 Risk Management

The Nexen PSM Hazard Identification and Risk Analysis (HIRA) element defines the methodology used to systematically identify hazards/threats, understand and evaluate the associated risk, recognize the exposures, and develop and implement controls to reduce the likelihood and/or consequence of a process safety incident/event.

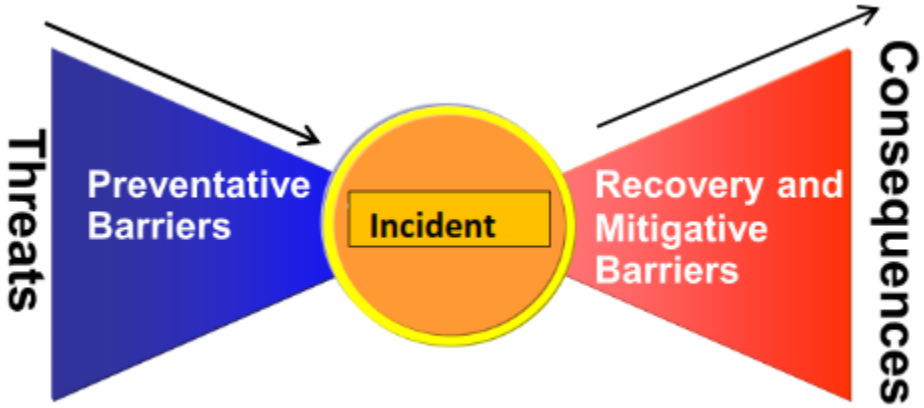
Nexen uses the “Bow Tie” analysis method (Figure 16.2) in the assessment of major hazards and risks. The Bow Tie is comprised of the following three main components:

- *Left Side of the Bow Tie:* Barriers that prevent a hazard from becoming an incident by stopping the threat and minimizing the likelihood of an incident occurring; (e.g., well control training, kick detection system, real time pore pressure assessment);

- *Middle of the Bow Tie*: An incident/event, such as the loss of well control, or release of a hazard (e.g., an uncontrolled flow of hydrocarbons into the wellbore);

- *Right Side of the Bow Tie*: Responses and recovery measures that mitigate the incident from becoming a more severe consequence (e.g., the BOP shutting in the well as a result of an uncontrolled flow of hydrocarbons into the wellbore, Oil Spill Response Plans, capping stack deployment, relief well drilling, etc.).

Figure 16.2 Bow Tie Analysis



Nexen's primary focus is on prevention (left side of the Bow Tie) with the goal being to put in place sufficient barriers in order to never have to implement the response and recovery measures (right side of the Bow Tie). Increasing the number and/or quality of the prevention barriers reduces the probability of an incident occurring and increasing the number and or quality of response and recovery barriers reduces the potential consequences of such an incident, in the unlikely event it is occurrence.

16.1.2.2 Asset Integrity and Reliability

The Nexen PSM Asset Integrity and Reliability element defines the minimum criteria and standards required for the procurement of major well work service contractors and the purchase/acquisition of equipment for drilling, completion, workover and abandonment operations for Nexen-operated projects. An Atlantic Canada Regional Quality Plan, which will reflect the expectations of the Nexen global governance documents, is in the process of being created. It will ensure that materials, products, tools, and equipment meet or exceed regulatory requirements, codes, specifications, standards, purchase requirements, and that they are fit for purpose. Testing and inspection schedules will be established for all equipment, with particular emphasis on well control, fluids handling and storage, and fluid transfer systems.

The MODU intake and acceptance process will be carried out in accordance with internal Nexen requirements, which meets or exceeds industry best practices and standards as well as regulatory requirements. It will ensure that MODUs are accepted in a state of readiness to perform as intended

during the contract term and function in a safe and reliable manner. This includes verification of the BOP / well control equipment.

16.1.2.3 Financial Responsibility

As part of the Authorization process Nexen will demonstrate to the C-NLOPB that it is capable of acting in a responsible manner for the life of the proposed work or activity. This includes suitable incident response plans, clean up measures and claim payments. For offshore drilling the C-NLOPB *Guidelines Respecting Financial Requirements* (August 2017, require an Operator to demonstrate Financial Responsibility and Financial Resources.

Proof of Financial Responsibility is required to allow the C-NLOPB access to funds, if required, for incident response or reparation, in the event an operator has not taken appropriate action in response to an incident. Nexen will provide proof of Financial Responsibility for $100 million to the C-NLOPB, which will remain in force for the duration of the work or activity for which the Authorization is issued. This will be provided through an agreed financial mechanism.

Proof of Financial Resources are required to ensure that the operator has the ability to respond to an incident, and pay for actual losses and damages incurred by any person as a result of the incident. Nexen will demonstrate proof of the financial resources necessary to meet a liability obligation of $1 billion, by providing a Statement of Net Assets or Funding Arrangements, together with one or more of the prescribed Financial Resource documents.

16.1.3 Nexen Global Drilling and Completions Governance

Nexen's Management System provides overall corporate governance. Nexen's global drilling and completion governance leverages industry best practices as well as the company's operational experience of executing drilling and completions projects globally, both onshore and offshore.

This system of governance results in control measures which reduce the risk of a well control event or blowout by yielding an appropriate well design (including casing, cementing, and fluids), properly specified well control equipment, robust drilling and monitoring procedures, suitably trained and competent workers, and reliable equipment.

A core element is the WDP which establishes the tasks, assurance, documentation, and other deliverables that a well project must address during the project life-cycle. There are also a number of other governance documents which set out the requirements and expectations for all of Nexen's global well operations.

One of the Nexen governing standards that is directly linked to the WDP is the Well Integrity Standard, the focus of which is to maintain full control of wellbore fluids at all times in order to prevent the loss of primary containment as well integrity concerns; safety of personnel; protection of the environment; the preservation of the asset; and the company's reputation. The main premise of this standard is to ensure that two independently tested well pressure barriers (or pressure containment envelopes) are available during all well activities and operations. This fundamental premise aligns with Nexen's corporate Process Safety governance.

16.1.3.1 Well Delivery Process

The WDP is a six stage process which covers well design, planning, and execution as well as post-well review and is a Nexen requirement to undertake the construction, modification, intervention, and/or operation of wells. The goal of the WDP is to ensure that all wells are planned, designed, and executed to meet regulatory requirements, industry and Nexen corporate standards.

The WDP affects the entire well and project life cycle, from exploration through field development and ultimately to field abandonment. Each stage of the WDP has a set of defined tasks including HIRA activities, technical assurance, and specific deliverables and each stage ends with a decision gate prior to proceeding into the next stage of work activity.

All elements of the primary and secondary well barrier envelopes including the BOP, marine riser, drilling fluid, casing, cement, wellhead, downhole tools, etc. will be verified ahead of and monitored throughout drilling operations. As mentioned above, steel pipe or casing is installed and cemented into place to stabilize the well bore, isolate pressure/fluids and prevent drilling fluid losses prior to drilling ahead with the next hole section. The BOP is run on the marine riser pipe and is connected to the wellhead system, creating a conduit between the MODU and the well. Verification and monitoring of this equipment involves a series of pressure tests, after it is installed and at regular intervals, in accordance with company and regulatory requirements. During drilling, the formation pressure is continuously assessed and the density of drilling fluid is adjusted to overbalance the well. If this primary barrier fails, the secondary barrier elements, including the BOP system, are used to prevent the well from flowing and regain control of the well. The BOP is a safety critical piece of equipment. It is comprised of high pressure valves that prevent hydrocarbons from escaping into the environment and multiple rams that are capable of shearing the drill string and sealing the well. It is generally capable of being activated from various locations on the MODU as well as from other support vessels using secondary BOP control intervention systems.

16.1.4 Contingency Planning and Emergency Response

In the unlikely event of a spill incident, effective preparedness measures can ensure a timely and coordinated response limiting any adverse environmental effects or other consequences. Nexen will have the necessary Emergency Response Plans (ERPs) in place to ensure a timely and effective response to potential major incidents. Although Nexen maintains the capability to respond to an incident, the potential for additional support may be contracted with external resources or providers and integrated where relevant into the ERPs. Spill response coordination in the oil and gas industry allows the industry to access additional relevant technical assistance and response resources in the event of a major incident.

16.1.4.1 Nexen Emergency Response Hierarchy

The Nexen emergency response management system is based on the Incident Command System (ICS). ICS is an international, standardized on-scene emergency management system specifically designed to allow users to adopt and integrate an organization structure equal to the complexity and demands of single or multiple incidents without being hindered by jurisdictional boundaries. Nexen has highly trained specialists and resources ready at all levels of the organization, from site and field first responders to Crisis Management teams.

For this Project, Nexen will employ a tiered system to categorize and respond to any type of incident:

- *Tier 1*: Response is within the capability of on-site resources.
- *Tier 2:* Response is within capability of regional resources.
- *Tier 3:* Response requires both national and international resources.

Determining the appropriate tiered response level and method for response to an incident will be dependent upon several factors including, but not limited to, the type of incident, location, size or volume of spill, time of year, weather, sea state, and resource availability.

Nexen has contractual arrangements in place that allow it to call upon various response contractors and support agencies to provide additional resources, depending on the size and scale of the incident. The specific resources or capabilities identified in an ERP will be in place prior to commencing operations. The additional resources are expected to include the following:

Tier 1 Response Resources

- Locally trained personnel and equipment onboard the MODUs, support vessels and the onshore Incident Command Post or Emergency Operations Centre (EOC).

Tier 2 & 3 Response Resources

- Regional organizations such as Eastern Canada Response Corporation (ECRC) which is certified by Transport Canada – Marine Safety, as a Response Organization under the Canada Shipping Act, 2001. ECRC was established to provide oil spill response services to companies operating in Canadian navigable waters in ECRC's geographical area of response south of the 60th parallel, including a response centre in St. John's, NL.
- International organizations such as Oil Spill Response Limited (OSRL) which is the largest international oil spill response cooperative that exists to respond to oil spills wherever in the world they may occur, by providing preparedness, response and technical advisory services.
- Specialized contractors such as Wild Well Control, which consists of various areas of expertise including: 1) Well Control which is responsible for firefighting, capping, surface and subsurface intervention; 2) Well Engineering and Technical Services which covers well modeling, risk management and response planning; and 3) Marine Well Services and Well Containment providing offshore emergency response, unconventional and platform decommissioning, subsurface intervention and containment.
- Mutual aid agreements with other oil and gas companies operating in the region.
- Government Agencies: At the provincial and federal levels of government, there are various agencies/departments that could provide regulatory oversight and advice in the event of a spill. These would include but not be limited to the C-NLOPB, Canadian Coast Guard Environmental Response Division, Environment and Climate Change Canada (Environmental Emergencies),

Department of Fisheries and Oceans, Joint Rescue Coordination Centre, Transport Canada and the Government of Newfoundland and Labrador.

16.1.4.2 Emergency Response Contingency Plans

Nexen is committed to responding to an incident with a full complement of response tools and strategies. Project specific ERPs will be developed for all critical activities contemplated for this Project including plans for all vessels and MODUs in addition to the onshore Emergency Response support teams at the local, regional and corporate level. Where necessary, bridging documents that clearly outline the requirements, interfaces and responses used among various parties will be developed for the Project. Outlined below is a list of proposed plans that will be developed for Project operations:

- *Vessel ERP*: A vessel-specific ERP that deals with managing emergency events related to the supply / support vessels used for the Project.

- *MODU ERP*: A MODU-specific ERP that outlines how various emergency teams (medical, fire, etc.) respond to and interface with the MODU EOC dealing with an emergency event related to the MODU.

- *Nexen Onshore ERP* (St. John's): This Plan will detail Nexen's emergency response organization, process and tactical support activities to assist the field asset (vessel or MODU) dealing with an emergency event.

- *Well Control ERP*: A regional well control ERP to reduce the potential effects of a blowout by preparing contingency equipment, procedures, and agreements in advance of an event and to facilitate a prompt and immediate response.

- *Oil Spill Response Plan* (OSRP): This Plan will detail Nexen's response protocols and strategies for responding to an oil spill of any size.

Well Control ERP

As noted above, Nexen will develop an Atlantic Canada Well Control ERP to reduce the potential effects of a blowout by preparing contingency equipment, procedures, and agreements in advance of an event and to facilitate a prompt and immediate response. A MODU / well specific addendum will be created for each well planned in Atlantic Canada. All of these documents will be submitted to the relevant regulatory authority (C-NLOPB) as part of the Operations Authorization process. In the unlikely event that each of the preventative barriers fail and an uncontrolled well event has occurred, where secondary BOP control intervention systems (ROV intervention, remote acoustic activation of the BOP) were unsuccessful, Nexen would immediately commence with mobilizing multiple contingency plans, including well capping / containment and relief well operations.

The Atlantic Canada Well Control ERP will include information and procedures related to:

- Initial Organization and Operations
- Incident Response Levels and Action Plans
- Notification and Contacts

- Incident Command System Overview
- Well Control Response Progression
- Onsite Well Control Operations Team
- Well Control Response Organization
- Equipment Mobilization / Logistics Plan
- Site Survey Procedure
- Dispersant System Deployment Procedure
- Debris Removal Procedure
- Capping Stack Deployment and Installation Procedure (primary and contingency capping stack)
- Capping Stack Shut-In Procedure (primary and contingency capping stack)
- Decontamination / Demobilization Procedures
- Relief Well Planning General Guidance
- Well Kill Equipment and Procedures.

Well Containment Procedure (Capping Stack)

A capping stack is a contingency well isolation device used to "cap'" a well while work to permanently control it is undertaken. The capping stack is employed in the event of primary drilling BOP failure. The capping stack is mated to the primary BOP stack by connecting to the top profile of the BOP, Lower Marine Riser Package (LRMP), or wellhead using a compatible connector. Once mated, the well is isolated via sets of rams or valves, depending on the system, and the well flow is stopped or diverted to surface vessels for management and recovery. Capping stacks have been successfully deployed on land and offshore wells.

For Nexen's Atlantic Canada wells, the plan, if necessary, would be to access a capping stack located in Montrose, UK, supplied by Wild Well Control. This capping stack is comprised of an 18-3/4 in. 15,000 psi-rated Cameron Type TL ram assemblies and a drilling spool with four 4-1/16-in. outlets, which facilitates the installation of chokes for soft shut-in operations or gooseneck assemblies for extended flow back/well kill operations. The capping stack also features chemical injection as well as internal pressure and temperature monitoring capability. The stack can be connected to a BOP or on top of a wellhead. The capping stack is deployable on either drill pipe or wire, and deployment is aided by a MODU or by crane / winch wire with quick change out of the running tool interface. Nexen would also have access to a contingency capping stack, located in Singapore.

Nexen's base plan would be to transfer the capping stack directly from Montrose, UK, to the wellsite by a vessel with sufficient capability for an indirect or offset installation. The transit time will vary based on seasonal metocean conditions. The mobilization and deployment of the capping stack is expected to range from 15 to 30 days depending on weather conditions, vessel availability, and the state of the equipment (deployment system, capping stack, and BOP/wellhead). The capping stack requires a specialized support vessel with sufficient crane capacity and a specialized crew for servicing, deployment, and installation. During well operations, Nexen will monitor and verify on a weekly basis the available vessel pool in the North Sea and maintain a list of vessels of opportunity capable of transporting and handling the capping stack.

Figure 16.3 Example Capping Stack



Relief Well Contingency Plan

A relief well contingency plan will also be developed as a part of the MODU / well specific plan referenced above. Capping the well will be the primary plan to secure the well and stop the flow. A relief well may also be required to permanently eliminate the flow and would be initiated at the time of the blowout, in parallel with the deployment of the capping stack. The relief well would be drilled using a similar operational plan as the blown out well. The primary relief well objectives are to perform a direct intersection with the blown out well, gain hydraulic communication, and pump kill fluid from the relief well into the blowout well. Nexen estimates that it could take 120 days to mobilize a relief well MODU / equipment, drill the relief well, and permanently kill the well.

Oil Spill Response Plan

Determining the appropriate tiered level and method for response to a hydrocarbon release at sea will be dependent upon several factors including, but not limited to, the type of incident involved, its location, volume of oil, oil type, time of year, weather, sea state and resource availability. Response actions will begin immediately upon the detection of a spill, provided it is safe to do so. The ability to control or

eliminate the source of the spill will be a key step in limiting the volume of the spill to the marine environment. A decision analysis on the appropriate type and level of response will be conducted as soon as possible once a spill is detected. The effectiveness of any response option will be constantly evaluated throughout the entire spill response.

16.1.4.3 Potential OSRP Tactics

In order to assess the potential risks and consequences of the various response options, including chemical dispersants, as part of its pre-drilling regulatory applications, Nexen will conduct a Net Environmental Benefits Analysis (NEBA). This assessment will allow spill responders and stakeholders to choose the best response options that will result in the maximum possible benefit and minimal potential effects to the environment. Response tools and strategies in the event of an oil spill may include, but are not limited to: mechanical recovery, surface/aerial/subsurface dispersants, in situ burning, shoreline protection and recovery, and well control.

Surveillance and Monitoring

In order to understand the extent, trajectory and behavior of any spill to help decide the most appropriate tactical response actions, one of the first priorities will be to establish appropriate surveillance and monitoring procedures. This can include observations from on the water and air resources as well as tracking using satellite spill tracker buoys. Surveillance and monitoring will provide not only the necessary information on extent, trajectory and behavior of a spill, but also help determine the effectiveness of any tactical response activities that have been implemented.

Mechanical Containment and Recovery

Offshore mechanical containment and recovery involves the use of booms to contain or corral the oil. Skimmers are then used to remove the oil from the surface of the ocean and transfer it back to a receiving tank onboard a vessel. Surveillance will also be required in order to locate and evaluate the effectiveness of this response option. MODUs and vessels will be equipped with Tier 1 response equipment such as sorbent boom which can be used to recover oil from the surface. Oil will adhere to the surface area of the boom or oleophilic material that can then be recovered back to the vessel.

Chemical Dispersion

The use of chemical dispersants as a potential response tool will also be considered as part of the above described decision analysis and ongoing response evaluations. This response option would be considered for larger, more persistent hydrocarbon releases and/or releases which have the potential to affect environmentally sensitive areas or the shoreline, or for smaller spills where it would be an effective response option. It may also be used when a release threatens the health and / or safety of personnel.

Where there is risk of harm to wildlife, coastlines or sensitive environments, the use of dispersant is often one of the most effective means of mitigating the effects of hydrocarbons in an open water environment. Effective dispersant application requires accurate spill detection. The slick location, thickness, and movement must be clearly identified and communicated to response managers and operations personnel. Dispersants do not remove the oil from the marine environment, but break it into

very small droplets that mix into the upper water column, promoting rapid degradation. Dispersants may be deployed subsurface at or near the wellhead location or on the surface by vessel or aircraft.

The NEBA will help guide Nexen and regulatory agencies as to whether or not this response tool would provide the overall greatest environmental benefit while minimizing any negative effects to the environment. Nexen will seek regulatory approval prior to the use of any dispersants.

In Situ Burning

In situ burning is a method used to quickly reduce the volume of oil on the ocean surface where oil is burned from the ocean's surface. In this situation, fire-resistant booms are used to contain the oil, which is then set on fire in a controlled burn. This response option will require suitable environmental conditions (wind and sea state) and specialized experts to execute. Nexen would seek regulatory approval prior to using this response option.

Natural Degradation

Natural dispersion occurs when the existing weather conditions help to disperse the oil into the water column. There are a number of different strains of bacteria in the ocean that break down the hydrocarbons into carbon and water. The marine environment has the capability to eliminate spilled oil through this long-term process of biodegradation. An important aspect to this response option will be to ensure that a monitoring/surveillance program has been established to ensure that the oil does not resurface or form emulsions.

Shoreline Protection and Clean Up Measures

In the unlikely event that oil threatens the shoreline, booms or barriers can be used to help protect sensitive areas and divert any surface oil to a suitable collection location. Should oil reach the shoreline, shoreline cleanup teams will be mobilized to assess the situation. The assessment will determine the response actions to be used to treat any oiled shoreline area, which may be different for different oiled areas. Treatment options can include, among other options, low pressure flushing, mechanical recovery, manual cleaning, soil washing, plowing, and other procedures. As with any option, monitoring and surveillance will be important to evaluate the effectiveness of this response.

Oiled Wildlife Response

In the unlikely event of a spill that affects wildlife, Nexen will have contractual arrangements in place for expert personnel and equipment required to support an oiled wildlife response. Select personnel onboard the MODU and vessels will receive training in oiled seabird handling prior to the commencement of any drilling program. Surveillance will be required to identify the location any oiled wildlife and concentration of wildlife near the spill area. Responders may also attempt to deter fauna from affected or potentially affected areas and apply pre-emptive capture and exclusion strategies. Any oiled wildlife that can be recovered will be transported to a treatment facility for rehabilitation.

Longer Term Remediations

Depending on the nature of any spill, a remediation program may be required to ensure that any potential post spill effects have been identified, characterized and a program established until the receiving environment has been restored to an appropriate and acceptable condition. This could involve sample collection and analysis to determine the residual effects of a spill and how these can be mitigated, and eventually eliminated. This remediation program would involve consultation with key regulatory agencies and affected stakeholders to ensure a holistic/all-inclusive approach will be implemented.

16.1.5 Applicable Regulatory Requirements

In addition to Nexen derived and implemented mitigations and precautionary approaches, an added layer of precaution comes from the various post-EA regulatory review and planning processes that will apply to this exploration drilling program (see Sections 1.3 and 1.5 for details). The regulatory review and approval processes and other requirements that apply to oil and gas activities in the Canada-NL Offshore Area are amongst the most rigorous and stringent in the world, and operators are required to demonstrate that they have the ability to undertake such activities in a safe and environmentally responsible manner through various project design measures, operational procedures, and response mechanisms. As part of its regulatory review and decision-making regarding proposed drilling programs and other activities in this jurisdiction, for example, the C-NLOPB receives and considers information from operators that detail the proposed drilling location and activities, the equipment and procedures involved, and the qualifications and training of personnel. The C-NLOPB's regulatory approval process requires, firstly, an authorization of the overall drilling program in the form of an Operations Authorization (OA), and secondly, a well approval in the form of an Approval to Drill a Well (ADW) for each well to be drilled.

Nexen is committed to obtaining all required permits, approvals and authorizations for the proposed Project, and the company and its contractors will comply with these and all relevant regulations and guidelines in planning and implementing the proposed marine exploration program that is the subject of this EIS. This includes the various mitigations identified and committed to in the preceding sections and/or as otherwise required by relevant regulatory authorities as part of Project planning and implementation, the implementation and effectiveness of which will be directed, managed and monitored in accordance with the company's applicable policies and procedures.

16.2 Potential Accidental Event Scenarios

A Major Accident Hazard (MAH) is an unplanned event with escalation potential for multiple fatalities, substantial environmental damage, significant asset damage that may include the loss of the asset, and high negative financial and/or reputational effects. MAH events are typically high consequence – low frequency (HCLF) events, which tend to make standard risk assessment processes unsuitable due to the unlikely chance of occurrence and the potential catastrophic consequences.

Nexen utilizes a MAH governance document for drilling and completions which describes the management of MAH events that have the potential to cause multiple fatalities, serious damage including environmental damage, and/or large financial or reputational loss. The purpose of the document is to provide a proactive and consistent approach that emphasizes the identification,

prevention, mitigation, control and response of major accident hazards. It supplements the Nexen PSM Framework. For all drilling and completions projects, a MAH Risk Register is created based on a dedicated MAH risk assessment which has the advantage of focusing on aspects of high consequence – low frequency (HCLF) events.

MAH scenarios may include but would not necessarily be limited to the following:

- Vessel collision
- Dropped objects (onboard the MODU or subsurface)
- Loss of MODU stability or structural integrity
- Loss of well control results in mudline blowout with hydrocarbon release

The sections below outline some of the potential causes of the MAHs listed above along with some potential safeguards and plans to mitigate the risk and control the hazard.

16.2.1 Vessel Collision

MAH: Vessel collision with MODU could result in worker injury or death, equipment loss / damage, and/or discharge to the marine environment.

Potential Causes:

- Human error
- Procedure deficient or missing
- Equipment failure
- Weather / environmental conditions
- Unauthorized vessel

Safeguards / Contingencies:

- Highly trained / competent personnel with appropriate certification
- Safety zone around the MODU monitored by the MODU and standby vessel
- Boundaries of safety zone will be communicated to mariners through a Notice to Shipping
- Marine contractor selection process
- Appropriate DP Class for vessels and MODU
- MODU / vessel intake process
- MODU / vessel specific operating criteria
- Regular collision drills / vessel collision assessment
- Robust positioning systems, certified watch-keepers, navigation aids, weather radars and alarms
- 24/7 manned bridge and engine room
- Man overboard response plan and fast rescue craft
- Weather forecasting / precautionary riser disconnect or MODU evacuation
- Emergency disconnect

16.2.2 Dropped Objects

Dropped objects include two MAHs; dropped objects on the MODU and dropped objects subsurface.

MAH: Major dropped object on the MODU could result in worker injury or death, equipment loss / damage, and/or discharge to the marine environment.

Potential Causes:

- Human error
- Procedure deficient or missing
- Equipment failure

Safeguards / Contingencies:

- Highly trained / competent personnel with appropriate certification
- Strictly follow / enforce the vessels barrier policy for red zones / travel path to avoid sensitive areas
- Pre-tour safety meetings, lifting assessment plans, Job Safety Analysis prior to heavy lifts
- Minimize lifts in heavy seas. Heavy lifts are planned operations
- Ensure manifests with load weights are available and accurate
- Follow contractor's procedures for proper handling and storage of materials as well as proper use, inspection, and maintenance of lifting / hoisting equipment
- Inspection of drill string, handling tools, lifting equipment, derrick components, etc.,
- Dropped object prevention scheme (DROPS) in place
- Medical response plan and use of correct PPE
- Audit of shore base prior to operations

MAH: Major dropped object subsurface in equipment loss / damage and/or a breach of well integrity and hydrocarbon release to environment

Potential Causes:

- Human error
- Procedure deficient or missing
- Equipment failure
- Weather / environmental conditions

Safeguards / Contingencies:

- Highly trained / competent personnel with appropriate certification
- Riser analysis including Vortex Induced Vibration, drive off/drift off, and transit analyses
- Riser management system
- Periodic inspection of riser components, handling tools, hoisting equipment (especially after harsh weather event)
- MODU / vessel specific operating criteria
- Run and pull BOP in designated safe zone
- Follow procedures for pulling / running riser
- Two hold points on the riser and BOP at all times
- Keep MODU floor / moon pool clear of non-essential personnel

- Safe handling zone identified and utilized
- Weather forecasting

If transiting with riser and BOP still attached to the MODU, additional mitigations include limiting MODU transit speed, use of a BOP tracking beacon, and ROV lead to assess potential upcoming obstacles.

16.2.3 Loss of MODU Stability or Station Keeping

MAH: Loss of MODU stability or station keeping could result in worker injury or death, MODU loss or damage, and/or spill to the environment (riser evacuation or well control event).

Potential Causes:

- Human error
- Procedure deficient or missing
- Equipment failure
- Structural failure
- Extreme weather event
- Ice accumulation on the MODU structure
- Ballast system failure
- Fire / explosion
- Vessel collision

Safeguards / Contingencies:

- Highly trained / competent personnel with appropriate certification
- Ballast control / positioning system manned 24/7
- Marine safety inspection during MODU acceptance process
- Ballast control procedures and computerized daily stability calculations
- Ballast control drills and MODU alarms
- Maintenance and inspection processes to test and regularly check equipment
- Safety equipment and lifeboats to accommodate personnel onboard
- Weak point analysis to detect potential system failure above the BOP
- ROV intervention / Deadman auto shear back up
- MODU classification audit / inspection
- MODU positioning system, controls, and alarms
- Mooring analysis (single or multi line failure)
- MODU / vessel specific operating criteria
- Emergency disconnect protocol to shut in well and allow MODU to move off location
- Weather forecasting

16.2.4 Loss of Well Control

MAH: Total Loss of Well Control results in mudline blowout with hydrocarbon release.

Potential Causes:

- Lack of offset well information / minimal drilling history
- Significant uncertainty on pore pressure fracture gradient (PPFG) estimate

- Lost circulation – loss zone / formation break down
- Poor cement job - design and/or execution
- Human error
- Equipment failure
- Inadequate well design
- Procedure deficient or missing
- Loss of riser margin (drift off / drive off, riser damage, poor planning)

Safeguards / Contingencies:

- Commitment to strong well control culture by operator and drilling contractor
- Shallow hazard survey and assessment - wells to be positioned away from potential hazards
- Special shallow gas procedures during drilling of riserless sections
- Real time pore pressure assessment while drilling; ensure fluid weight overbalances predicted pore pressure including a safety margin
- Highly trained / competent personnel (operator, drilling contractor, and third party services) with appropriate level of deepwater well control training
- Kick detection instrumentation and procedures
- Well design / kick tolerance follows Nexen governance
- Well control procedures and equipment / kick plan in drilling program and posted on the MODU floor / well control drills and table top exercises
- Inspection, testing, and maintenance of well barriers including casing, wellhead, and BOP equipment
- Rigorous audit / assurance process for drilling contractor and tangible equipment ordered
- BOP enabled with Autoshear and Deadman features; ROV equipped with intervention equipment to manually function the BOP
- Maintain riser margin or ensure other mitigation for two barriers prior to disconnect
- Well Control / Oil Spill Response Plans

16.2.5 Potential Spill Scenarios

Some of the risks and potential accidental events described above could result in an unplanned release of hydrocarbons, chemicals, synthetic based drill cuttings or emissions, potentially resulting in adverse environmental effects. Additionally, there are some potential operational spill events that could occur from anywhere that hydrocarbons or chemicals are stored or transferred on the MODU or support vessels.

Based on a consideration of Project activities and potential environmental risk, three accidental spill scenarios were selected for detailed spill fate and behaviour modelling. These spill scenarios are considered representative of credible worst case spill scenarios that could result from an accidental event, and include:

- Diesel spills
- Subsurface blowout
- Drill fluid (SBM) spills

16.2.5.1 Marine Diesel Spills

Spills to the marine environment can occur during the standard and routine use, storage and movement of fuels on MODUs and supply vessels. These often comprise instantaneous or short-duration discharges into the marine environment during planned drilling activities. A large diesel spill could also occur as a result of a vessel collision and complete loss of cargo or fuel from a supply vessel.

16.2.5.2 Subsurface Blowout

A blowout is an unplanned and uncontrolled release of petroleum from a well after a failure in the drilling system and its associated pressure control barriers, resulting in the continuous discharge of hydrocarbons into the surrounding waters. Blowout events could potentially occur at various stages of drilling , the nature, duration, behaviour and outcomes of which depend on various factors, such as water depth, the amount and properties of the hydrocarbons involved, currents and other oceanographic features, and other factors.

16.2.5.3 Drill Fluid (SBM) Spill

Another potential spill scenario involves a spill of synthetic-based drilling muds (SBM) during drilling operations in the Project Area. SBMs are defined as drilling fluids in which the continuous phase consists of a synthetic base fluid, while the dispersed phase consists of brine and other additives. As further discussed in Section 8.3.4, SBMs have been developed as a more environmentally friendly alternative to oil-based muds (OBMs), as the synthetic fluids that comprise the continuous phase exhibit low toxicity to aquatic life and are more biodegradable in marine sediments than OBMs. These spills may occur as a result of an accidental deck release, a subsurface release through a crack or orifice in a flex joint, riser or lines, or a bottom release due to an emergency riser disconnect event (due to hazardous weather or other cause).

16.2.5.4 Potential Nearshore Accidental Events

As described in Section 2.5, the Project will include supply vessel and aircraft traffic between a yet to be determined existing port facility in Eastern Newfoundland and the Project Area as required throughout the duration of the Project. Supply vessels that are involved in Project activities will travel directly between the MODU operating within an EL in the Project Area and an established port facility in Eastern Newfoundland, a practice which is common in the oil and gas industry that has been active in this region for several decades. This component of the Project will therefore involve standard and relatively routine vessel traffic to and through a portion of the Eastern Newfoundland Offshore Area.

While there is some potential for an accidental event to occur during any such activity, the possibly of, and potential environmental effects that may be associated with, any such incident are very low. The supplying and off-loading of Project-related supply vessels will again occur within an existing industrial port facility, which handles vessel activity associated with multiple offshore operations and which operates in compliance with relevant legislation and regulations around materials handling, marine transits and required spill prevention and response. Similarly, vessel traffic to and from these facilities in the nearshore environment will likewise be subject to applicable regulatory requirements, including requirements for vessel pilotage as required.

There have been no known near-shore supply vessel groundings or spills over the history of oil and gas exploration in the Canada-NL Offshore Area. Given the absence of such incidents, the routine nature and limited frequency and duration of these vessel activities for this Project, the various prevention and response measures in place for these activities, and the fact that the offshore trajectory and fate model for possible batch spills showed that most released diesel is predicted to evaporate and degrade quickly (Section 16.4), with little predicted contamination, there are no plausible adverse environmental effects resulting from such a scenario. Other analysis of potential hydrocarbon spills in the near shore environment off St. John's NL have likewise indicated that such a spill event would see oil moving to the east and not contacting the shoreline (RMRI nd).

The measures to be put in place to prepare for, prevent, and respond to such a scenario are largely the same as those for offshore incidents, presented in Section 16.1. Likewise, the existing mechanisms and arrangements with response organizations for emergency response are the same as those for offshore incidents presented in that section.

The likelihood of an offshore spill reaching shore is presented in Section 16.4, and the subsequent effects (including effects on species at risk and their critical habitat, colonial nesters and concentrations of birds, and their habitat) of any such spills are presented in Section 16.6.

16.3 Spill Risk and Probabilities

16.3.1 Historical Spill Data - Canada-NL Offshore Area

Exploration and production hydrocarbon spill information for the Canada-NL Offshore Area is available from the C-NLOPB web site (C-NLOPB 2017).

Figure 16.4 presents an annual inventory count of oil spills for the Canada-NL Offshore Area for the period 1997 to 2017 (updated November 2, 2017 for spills greater than 1 L; October 3 for those less than 1L) by spill size, where three categories have been defined: a) 1 L or less; b) between 1 and 7,950 L (about 50 bbl in order to generally align with the US Outer Continental Shelf threshold); and c) greater than 7,950 L.

Spills have occurred in every year since 1997. The historical total during this 21-year period is 526 spills: 269 spills less than or equal to 1 L, 249 spills of 1 L to 7,950 L, and eight spills greater than 7,950 L. Smaller spills of size less than or equal to 1 L have ranged in number from none in 1997 to 34 in 2007, with an average of 12.8 and a median of eight spills per year. Spills between one and 7,950 L have ranged in number from one in 2016 and 2017 to 38 in 1999, with an average of 11.9 and a median of nine spills per year. The eight recorded spills of over 7,950 L occurred one each in the years 2002, 2003, 2007, 2011 and 2015, and three in 2004; with a historical average of 0.4 spills of this size per year.

Figure 16.5 presents corresponding annual total spill volumes, including all spill sizes. The maximum annual spill total volume was 274,008 L in 2004 resulting from the November spill of 165,000 L of crude oil at Terra Nova due to produced water separation process failure, and the October spill of 96,600 L of SBM at White Rose due to a diverter line source. The total spill volume over the 21-year 1997-2017 period is 492,697 L, with an average of 23,462 L and a median of 5,327 L of oil spilled per year.

Figure 16.6 presents a breakdown of the spill product associated with each incident for which the spill volume was greater than 1 L. As indicated, hydraulic and lubricating oil accounted for about 32 percent (82 of 257) of the spill incidents, while crude oil accounted for about 25 percent (63 incidents). Since 2011 there has been a noticeable reduction in for the number of spills and amount of oil spilled, while there are no clear trends in which types of product are spilled.

Figure 16.4 Number of Spill Incidents Canada- NL Offshore Area (1997-2017)

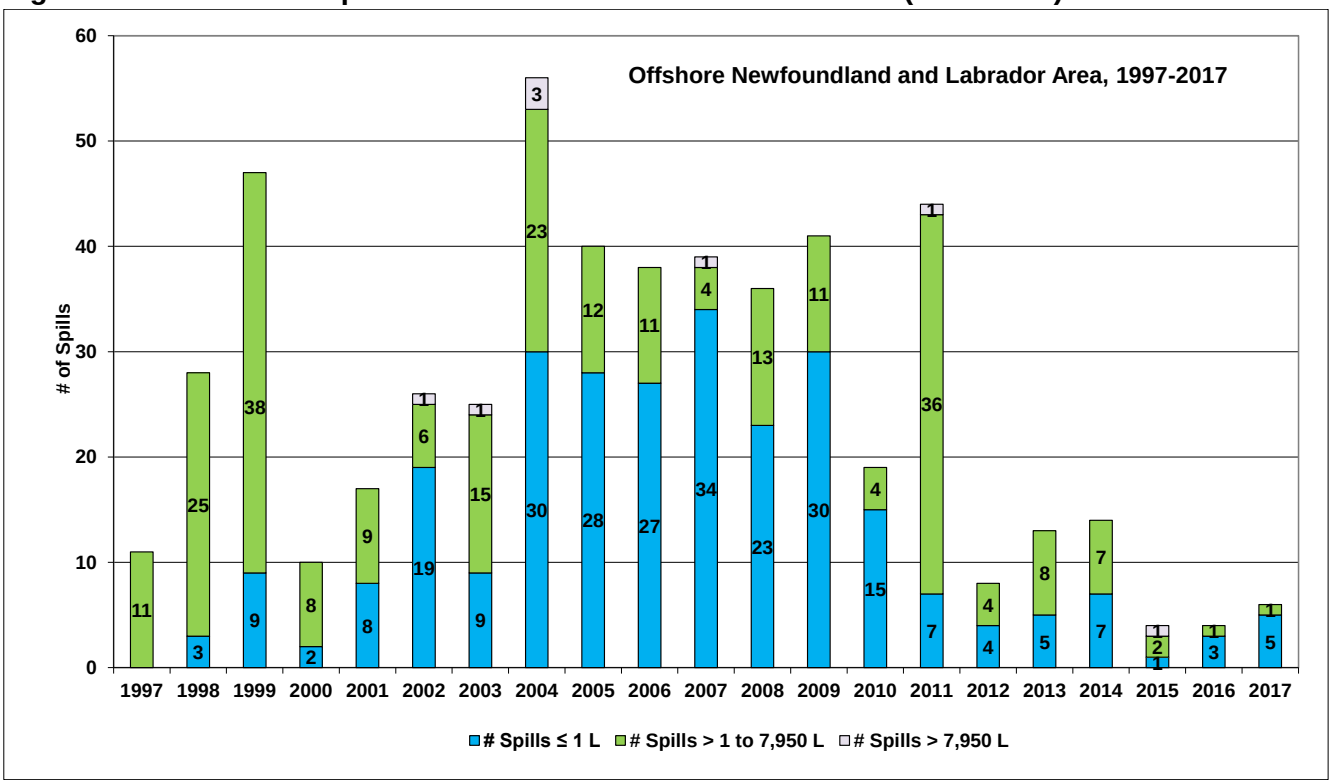


Figure 16.5 Total Spill Volume, Canada-NL Offshore Area (1997-2017)

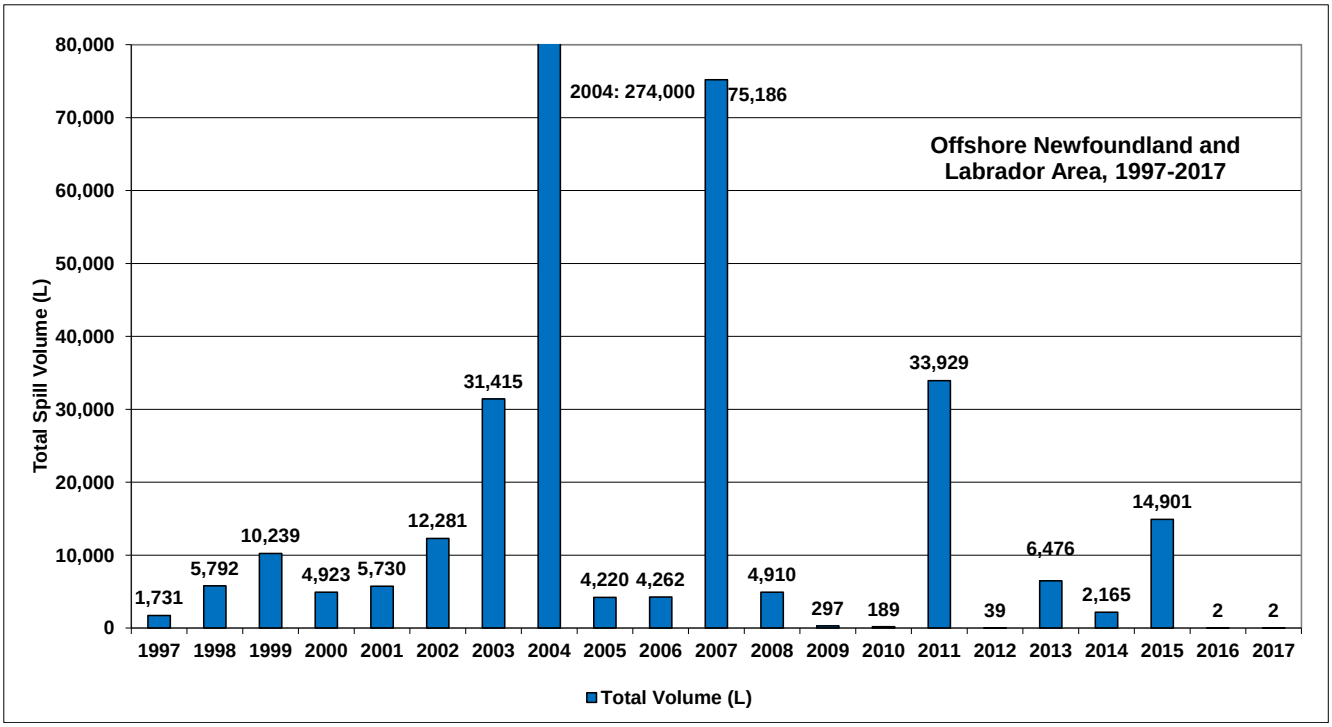
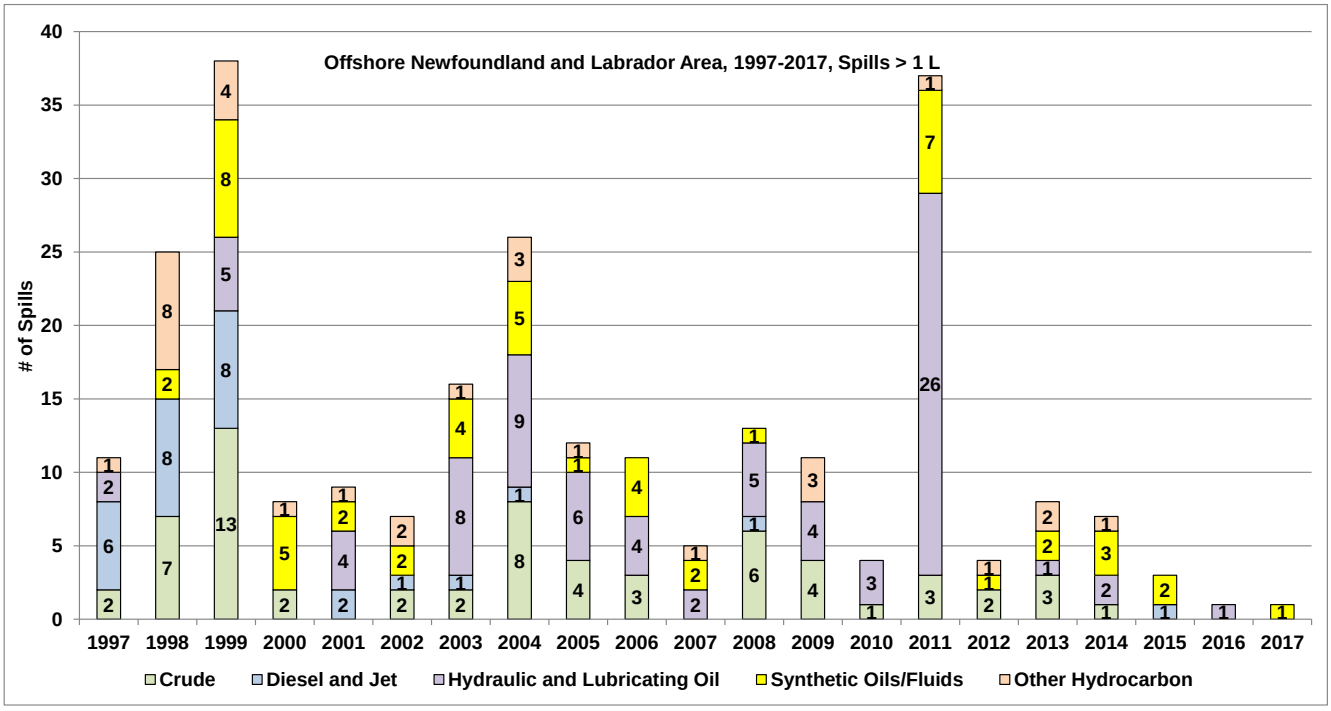


Figure 16.6 Spills by Year by Type, Canada-NL Offshore Area (1997-2017, Spills > 1 L)



The following figures present the cumulative (1997-2016) spill frequency and spill volume by type for both exploration drilling (Figures 16.7 and 16.8) and development drilling and production (Figures 16.9 and 16.10) in the Canada-NL Offshore Area, based on available C-NLOPB statistics.

For exploration drilling in the Canada-NL Offshore Area from 1997-2016, synthetic oils and fluids constituted 18.6 percent of all spill incidents, while making up 95.6 percent of the total volume of spills. For development drilling and production, synthetic oils and fluids constitute a similarly low proportion (10.6 percent) of all spill incidents, while making up 49.6 percent of the total volume of spills. Spills of crude oil in the Canada-NL Offshore Area from 1997-2016 accounted for 2.1 percent of the total volume of materials spilled during exploration drilling and 49.3 percent of spilled volumes as a result of development drilling and production activities.

Table 16.1 provides annual and overall spill statistics for exploration and production activities in the Canada-NL Offshore Area for the five-year period from 2012-2016. Over that timeframe there were from 4 to 14 spills (of any size) per year, and a total of 44 spills, which resulted in 23,578 L of SBM and all other hydrocarbons being spilled into the marine environment. The total number of spills resulting specifically from exploration activities off Newfoundland and Labrador over that five-year period is five, which collectively totalled 15,640 L of spilled material. Almost all of the material spilled during that period was comprised of SBMs, with the remaining less than one percent coming from two spills totalling 2 L of other hydrocarbons (Table 16.1).

Figure 16.7 Spill Frequency by Type, Exploration Drilling - 1997-2016 (% of Incidents)

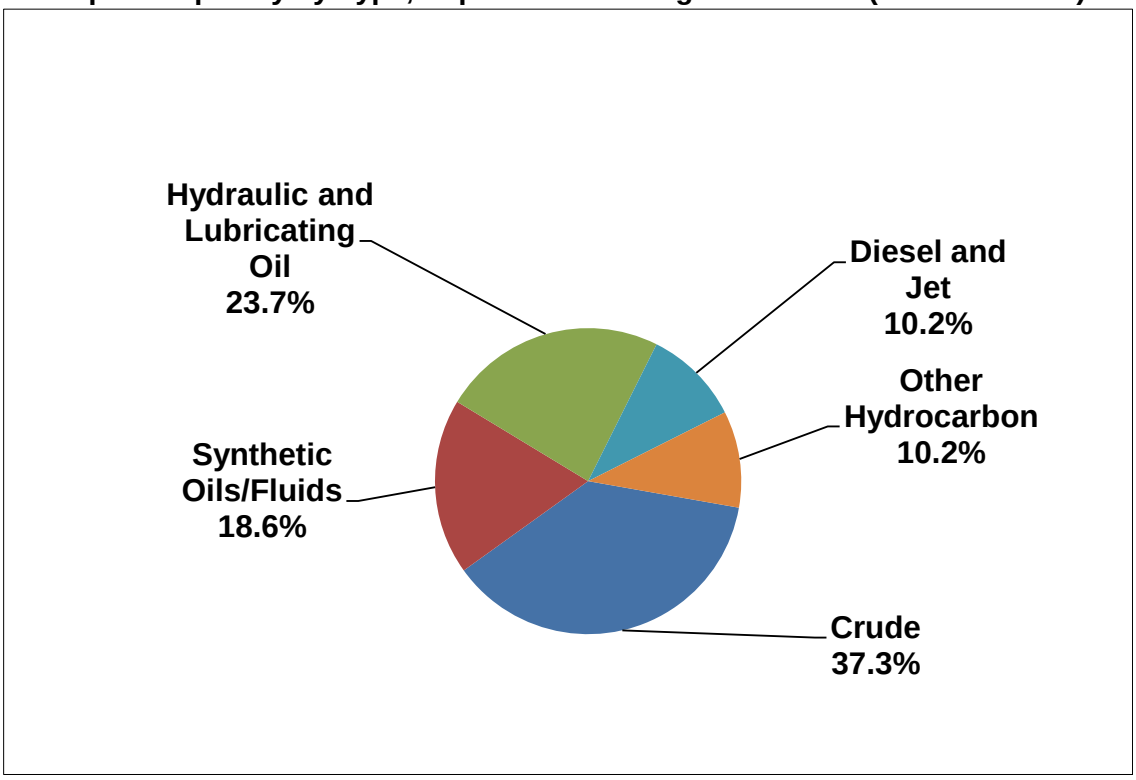


Figure 16.8 Spill Volume by Type, Exploration Drilling - 1997-2016 (% of Volume)

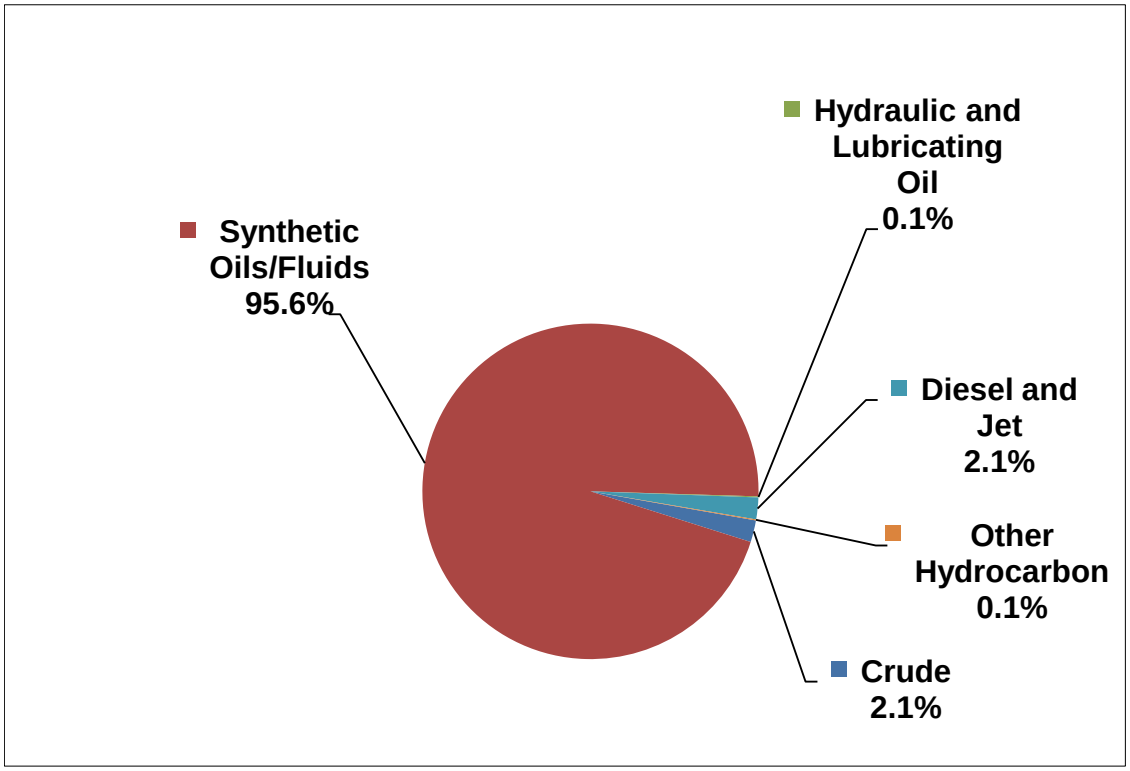


Figure 16.9 Spill Frequency by Type, Development Drilling & Production - 1997-2016 (% of Incidents)

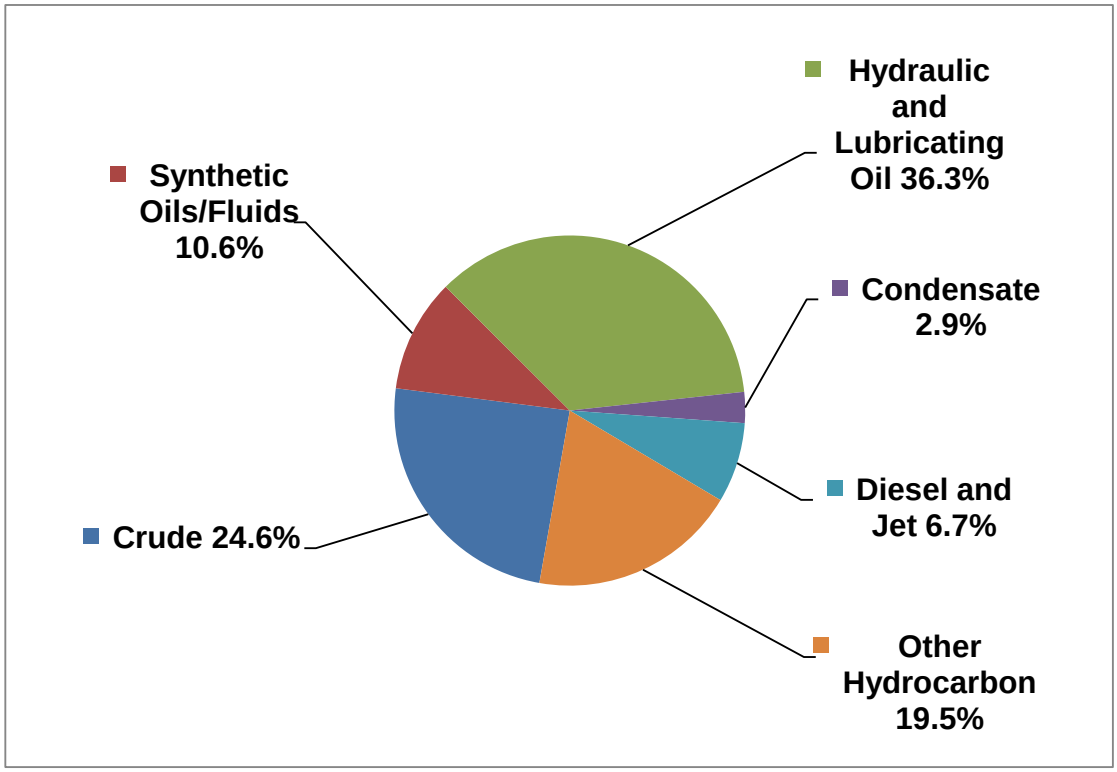


Figure 16.10 Spill Volume by Type, Development Drilling & Production - 1997-2016 (% of Volume)

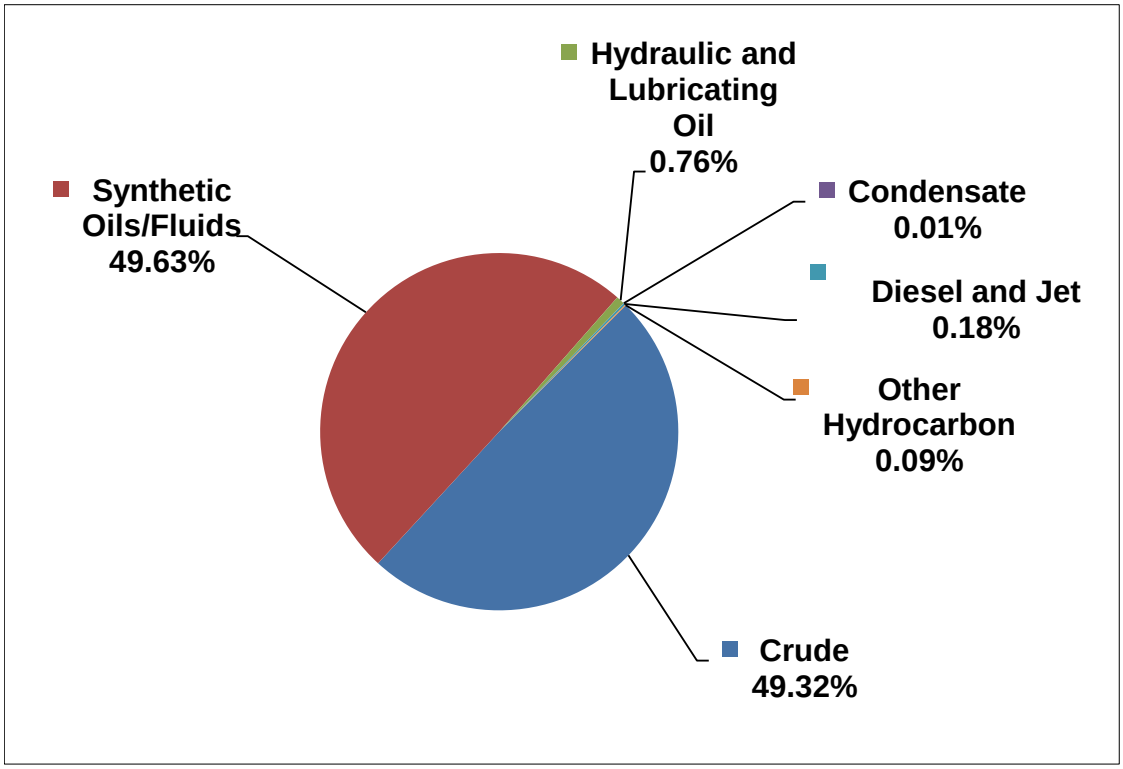


Table 16.1 Exploration and Production Hydrocarbon Spill Information, Canada-NL Offshore Area (2012 – 2016)

	2012		2013		2014		2015		2016		Total 2012-2016	
	Number	Volume (L)	Number	Volume (L)	Number	Volume (L)	Number	Volume (L)	Number	Volume (L)	Number	Volume (L)
Exploration Drilling												
Synthetic Based Drilling Fluid	1	27.70	0	0.00	1	860.0	1	14,750.00	0	0.00	3	15,637.70
All Other Hydrocarbons	0	0.00	0	0.00	0	0.00	1	0.01	1	2.00	2	2.01
TOTAL	1	27.70	0	0.00	1	860.00	2	14,750.01	1	2.00	5	15,639.71
Development Drilling and Production												
Synthetic Based Drilling Fluid	0	0.00	2	223.00	3	1,075.50	1	143.00	0	0.00	6	14,415.00
All Other Hydrocarbons	7	11.10	12	6,253.17	10	229.05	1	3.00	3	0.36	33	6,496.68
TOTAL	7	11.10	14	6,476.17	13	1,304.55	2	146.00	3	0.36	39	20,911.68
Total: Exploration and Production												
Synthetic Based Drilling Fluid	1	27.70	2	223.00	4	1,935.50	2	14,893.00	0	0.00	9	17,079.20
All Other Hydrocarbons	7	11.10	12	6,253.17	10	229.05	2	3.01	4	2.36	35	6,498.69
TOTAL	8	38.80	14	6,476.17	14	2,164.55	4	14,896.01	4	2.36	44	23,577.89
Source: Environment Statistics, Summary Information (1997-2016) Spill Frequency and Volume, C-NLOPB (2017)												

16.3.2 Calculated Probabilities of Spills from the Project

The probability and frequency of potential blowout and batch spills that may result from the various activities that comprise this Project were calculated based on a review of national and international records of historical offshore spill events (SL Ross 2017, see detailed report in Appendix F).The calculated oil spill probabilities and frequencies for the Project, expressed on a per well drilled basis, are summarized In Table 16.2.

As noted, the highest potential frequencies are for the smaller, operational spills. Spills less than one barrel in size (less than 159 litres) may occur one to two times per well, based on recent petroleum development experience off Newfoundland and Labrador. Although these smaller spills may occur more often, the median volume is four litres. Historical spill records for very small spills do not differentiate between production and exploration activities, and so the probability of very small spills during exploration activities may be overestimated. Batch oil spills during exploration drilling that are larger than one barrel but less than 50 barrels have about a 1-in-70 (1.43 percent) chance of occurring per well. Oil spills in the 50 to 999 barrel range may have about a 1-in-300 (0.33 percent) chance of occurring per well, based on experience in the U.S. Outer Continental Shelf (OCS). There is about a 1-in-3,200 (0.03 percent) chance per well of having any sort of blowout. (i.e., liquid or gas) during normal drilling, after the blowout preventer is installed.

The chances of an extremely large (greater than 150,000 barrel), very large (greater than 10,000 barrel), and large (greater than 1,000 barrel) oil well blowout during exploration drilling are very small: about a 1-in-25,000 (0.004 percent), 1-in-13,000 (0.008 percent) and 1-in-10,000 (0.01 percent) chance per well, respectively. It should also be noted that due to the infrequency of these occurrences, these predictions are based on worldwide data, and are strongly influenced by blowouts that occurred in parts of the world where drilling regulations may be less rigorous than those in the Canada-NL Offshore Area, and in most cases occurred prior to modern safety improvements.

Table 16.2 Calculated Oil Spill Probabilities and Frequencies

Event	Spill Probability (Spills Per Well Drilled)	Spill Frequency
Blowout (All Types)[1]		
Deep blowout during exploration drilling	3.10×10^{-4}	1 per 3,226 wells
Blowout Resulting in Large Spill[2]		
Extremely Large (> 150,000 bbl)	3.92×10^{-5}	1 per 25,510 wells
Very Large (> 10,000 bbl)	7.84×10^{-5}	1 per 12,755 wells
Large (> 1,000 bbl)	9.80×10^{-5}	1 per 10,204 wells
Non-Blowout Batch Spill of Petroleum[3]		
Large (> 1,000 bbl)	6.33×10^{-5}	1 per 15,787 wells
Medium (50 to 999 bbl)	3.34×10^{-3}	1 per 298 wells
Small (1 to 49.9 bbl)	1.45×10^{-2}	1 per 69 wells
Very Small (<1 bbl)	1.50	1 per 0.67 wells
SBM Spills[4]		
Large (> 1,000 bbl)	-	-
Medium (50 to 999 bbl)	2.33×10^{-2}	1 per 2,100 wells
Small (1 to 49.9 bbl)	8.33×10^{-2}	1 per 12 wells

Event	Spill Probability (Spills Per Well Drilled)	Spill Frequency
Very Small (<1 bbl)	0.17	1 per 5.9 wells
[1] Based on exploration wells drilled to North Sea Standard, 1985 to 2005. [2] Based on world-wide blowout spills from exploration drilling, all time. [3] Large and medium spill data based on U.S. OCS exploration drilling, 1980 to 2011; small spill data based on Newfoundland and Labrador exploration and delineation drilling, 2000 to 2016; very small spill data based on Newfoundland and Labrador exploration, delineation and production drilling, 2000 to 2016. [4] Based on Newfoundland and Labrador exploration, delineation and production drilling, 1997 to 2016		

16.4 Fate and Behaviour of Potential Oil Spills

In order to assess the fate and behavior of potential spill scenarios, RPS (2017, see Appendix G) conducted trajectory and fate modelling related to potential (hypothetical, example) exploration example wells at EL 1144 and El 1150. Modelling and analyses were performed to help support and give context to the accidental events effects assessment reported in this chapter. To be conservative, the oil spill modelling did not include consideration of mitigations such as response procedures.

16.4.1 Locations and Scenarios

As noted in Section 16.2, several scenarios were modelled to capture the range of scenarios listed in Tables 16.3 and 16.4. Two hypothetical release locations of different water depths were used for modelling subsurface blowouts, including one site in each of ELs 1144 and 1150 (see Figure 8.2).

The example well site locations were selected to represent the potential range of credible drilling scenarios. The criteria used included: reservoir type and properties; administrative boundaries (e.g., licence area boundaries); and the physical environment (e.g., potential range of water depths, proximity to more sensitive areas, potential range of ocean currents). The sites were placed on either side of the Flemish Pass with one example well as deep water and deep reservoir depth and one example well as shallower water and shallower reservoir depth.

EL 1144 was a deeper Jurassic example well and the EL 1150 was a shallower Cretaceous example well. Subsurface blowouts near the seafloor were modelled separately with OILMAPDeep and SIMAP at each location in a stochastic analysis that included 119 individual model runs per location. This analysis investigated the influence of environmental variability, throughout the year over multiple years, on trajectory and fate. Results from stochastic analyses were broken into two seasons depending on the majority of modelled days during ice free conditions (summer) from May – October or periods with ice-cover (winter) from November – April. Analysis of representative deterministic scenarios were conducted for individual trajectories that were identified as the 95th percentile for surface oil exposure, contact with shoreline, and water column contamination from blowouts near the seafloor modelled in the stochastic analysis, as well as for instantaneous surface “batch spills” of marine diesel. Two hypothetical release locations were used for the modelling of the batch spills and vessel collision; the surface spills were modelled at site EL 1144 and the Vessel Collision Location (VCL) spill represents the midpoint between St. John’s, NL and the Project Area.

Table 16.3 Modelled Spill Scenarios for EL 1144 and EL 1150

Hypothetical Spill Location	Depth of Release	Release Duration	Release Rate (bbl/d)	Model Duration	Number of Model Runs	Released Product	Release Type	Release Volume
EL 1144	1,137 m	30 days	184,000	60 days	119**	BdN	Subsurface Blowout	5,520,000 bbl
EL 1150	378 m		44,291					1,329,000 bbl
EL 1144	Surface	Instantaneous		30 days	2	Marine Diesel	Batch Spills	100 L & 1,000 L
VCL*					1		Vessel Collision	750,000 L

* The Vessel Collision Location (VCL) represents the midpoint between St. John's, Newfoundland and the Project Area
**119 model runs consisted of 59 winter and 60 summer for each site

Table 16.4 Selected Representative Deterministic Scenarios

Scenario Parameter	Release Parameters for Representative Deterministic Scenarios								
	95th Percentile – EL 1144 Example Well			95th percentile – EL 1150 Example Well			Marine Diesel Releases		
Representative Scenario	Surface Oil Exposure Area	Water Column Oil Mass	Shoreline Contact Length*	Surface Oil Exposure Area	Water Column Oil Mass	Shoreline Contact Length	Small Volume	Large Volume	Full Tank Release
Release Site	EL 1144			EL 1150			EL 1144		VCL
Release Type	Subsurface Blowout						Bunkering		Supply Vessel Collision
Depth of Release	1,137 m			378 m			Surface		
Released Product	BdN			BdN			Marine Diesel		
Release Rate	184,000 bbl/day			44,291 bbl/day			n/a		
Release Duration / Model Duration	30d / 60d			30d / 60d			Instantaneous/ 30d		
Total Release Volume	5,520,000 bbl			1,328,730 bbl			100 L	1,000 L	750,000 L
Modelled Start Date and Season	06/13/2006 Summer	03/22/2008 Winter	10/2/2008 Summer	04/20/2007 Summer	12/03/2006 Winter	No Shore Contact	6/15/2009 summer (calmest site-specific period identified between 2006-2010)		6/14/2009 summer (calmest site-specific period identified between 2006-2010)

*The 99th percentile shoreline contact length case was identified for analysis as the 95th percentile case resulted in no shoreline oiling

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16.4.2 Overall Modelling Approach

Stochastic modelling provides a probabilistic view of the likelihood that a given region might be exposed to released hydrocarbons over specified thresholds given the range of possible environmental conditions that may occur within and across multiple years. A deterministic analysis then provides a view of the time history of the specific movement and behavior of released product from a given (e.g., representative) individual release. Together, these methods provide a comprehensive analysis of both the likelihood and degree of potential exposure. Both modelling approaches are discussed below and give complementary information that helps to frame the potential exposure regime for the environmental effects assessment of the hydrocarbon spill scenarios.

16.4.2.1 Stochastic Approach

The modelling study (Appendix G) employed a stochastic approach to determine the range of potential trajectories and fates of hypothetical hydrocarbon releases based upon the variable forcing conditions (e.g. wind and currents). In order to reproduce the natural variability of winds and currents, the model requires both spatially- and temporally-varying datasets. Historical observations and models of multiple-year wind and current records were used to perform the simulations within the coinciding time period. These datasets allow for reproduction of the natural variability of the wind and current speeds and directions. Optimally, the minimum time window for stochastic analysis is at least five years so that various weather patterns from year to year are represented. Using wind and current data from throughout this long time period, a sufficient number of model runs will adequately sample the variability in the time sequences of wind and current speeds and directions in the region of interest, and result in a prediction of the probable oil pathways for a release at the prescribed location. Stochastic modelling provides a probabilistic view of the likelihood that a given region might experience effects from released hydrocarbons over many possible environmental conditions occurring within and across multiple years.

The region where the initial momentum of the discharge and the buoyancy flux dominates the mixing process is referred to as the near-field region of the model. As the plume moves away from the discharge source, the characteristics at the source become less important and the ambient conditions have more influence on the fate of the discharge plume. This is referred as the far-field region. These near-field plume dynamics include the location and size of the subsurface plume at the termination (i.e., trap) height and the characterization of the oil droplet size distribution. Typically, the near-field model is on the timescale of seconds and length scale of hundreds of metres, whereas the far-field model is on the scales of hours/days and many kilometres. Hypothetical release scenarios were simulated using two three-dimensional trajectory and fate models developed by RPS to capture both the near-field and far-field region; the OILMAPDeep and SIMAP modelling packages. OILMAPDeep was used to define the near-field dynamics of the subsurface blowout plume which was then used as the initial conditions for the far-field modelling conducted in SIMAP. These models are described in detail in Appendix G

SIMAP was used to determine the potential footprint of areas that may be affected by a release of oil based upon variability in meteorological and hydrodynamic conditions. A stochastic scenario is a statistical analysis of tens to hundreds of individual trajectories resulting from the same release event, with each trajectory starting at a randomized time from a relatively long-term window. The stochastic approach analyzes the same type of release under varying environmental conditions to provide the anticipated variability in probable movement and behaviour of the release. In order to reproduce the natural variability of winds and currents, the model requires both spatially- and temporally-varying

datasets (e.g., hourly to daily time scales) spanning at least five years. A sufficient number of model runs will adequately sample the variability in wind and current speed and direction in the region of interest, and will result in a prediction of the many possible oil pathways for a release at the prescribed location.

In a stochastic analysis, multiple model runs (tens to hundreds of releases) are placed upon one another to create a cumulative footprint of releases. Further analyses provide two types of information for specific thresholds of interest (Tables 16.5 and 16.6) including: 1) the probability that a given area may experience oil exposure, and 2) the shortest amount of time required for oil to reach any point within the predicted area. To analyze the probability or likelihood of potential effects, specific thresholds for surface oil thickness and shoreline oiling are used. Figures and further analyses include the lower socioeconomic thresholds of concern calculated from stochastic results.

It is important to note that although relatively large footprints of oil contamination are depicted for stochastic analyses, they are not the expected distribution of oil from any single release. These maps do not provide any specific information on the quantity of oil in a given area. They simply denote the probability of oil exceeding the given threshold passing through each grid cell location in the model domain over the entire model duration (60 days), based on the entire ensemble of runs (119 individual releases for both locations). Only probabilities of greater than or equal to one percent were included in the map output, as lesser probabilities represent random noise in each set of 119 trajectories. Stochastic maps of water column contamination of dissolved hydrocarbons depict the likelihood that concentrations will exceed the identified threshold at any depth within the water column, but do not specify the depth at which this occurs and do not imply that the entire water column (i.e., from surface to bottom) will experience a concentration above the threshold.

In addition to their use in EAs, stochastic results are useful in helping plan any required oil spill response, as they characterize the probability that regions may experience contamination above specified thresholds, taking into account the natural variability (i.e., winds, currents, etc.) that is expected from many potentially-different release scenarios over time.

Table 16.5 Thresholds Used to Define Areas and Volumes Exposed Above Levels of Concern

Threshold Type	Cutoff Threshold	Rationale/Comments (Socioeconomic, Response, Ecological)	Visual Appearance	References
Oil Floating on Water Surface	0.04 g/m²	*Socioeconomic*: A conservative threshold used in several risk assessments to determine effects on socioeconomic resources (e.g., fishing may be prohibited when sheens are visible on the sea surface). Socioeconomic resources and uses that would be affected by floating oil include commercial, recreational and subsistence fishing; aquaculture; recreational boating, port concerns such as shipping, recreation, transportation, and military uses; energy production (e.g., power plant intakes, wind farms, offshore oil and gas); water supply intakes; and aesthetics.	Fresh oil at this minimum thickness corresponds to a slick being barely visible or scattered sheen (colorless or silvery/grey), scattered tarballs, or widely scattered patches of thicker oil.	French McCay et al, (2011); French McCay et al (2012); French McCay (2016); Lewis (2007), Bonn Agreement
	10 g/m²	*Ecological*: Mortality of birds on water has been observed at and above this threshold. Sublethal effects on marine mammals, sea turtles, and floating Sargassum communities are of concern.	Fresh oil at this thickness corresponds to a slick being a dark brown or metallic sheen.	French et al, (1996); French McCay (2009) (based on review of Engelhardt, 1983, Clark, 1984, Geraci and St. Aubin 1988, and Jenssen 1994 on oil effects on aquatic birds and marine mammals); French McCay et al (2011); French McCay et al (2012); French McCay (2016)

Threshold Type	Cutoff Threshold	Rationale/Comments (Socioeconomic, Response, Ecological)	Visual Appearance	References
Shoreline Oil	1.0 g/m²	*Socioeconomic/Response:* A conservative threshold used in several risk assessments. This is a threshold for potential effects on socioeconomic resource uses, as this amount of oil may trigger the need for shoreline cleanup on amenity beaches, and affect shoreline recreation and tourism. Socioeconomic resources and uses that would be affected by shoreline oil include recreational beach and shore use, wildlife viewing, nearshore recreational boating, tribal lands and subsistence uses, public parks and protected areas, tourism, coastal dependent businesses, and aesthetics.	May appear as a coat, patches or scattered tar balls, stain	French-McCay et al (2011); French McCay et al (2012); French McCay , (2016)
	100 g/m²	*Ecological*: This is a screening threshold for potential ecological effects on shoreline flora and fauna, based upon a synthesis of the literature showing that shoreline life has been affected by this degree of oiling. Sublethal effects on epifaunal intertidal invertebrates on hard substrates and on sediments have been observed where oiling exceeds this threshold. Assumed lethal effects threshold for birds on the shoreline.	May appear as black opaque oil.	French et al, (1996); French McCay (2009); French McCay et al, (2011); French McCay et al, (2012); French McCay, (2016)
In Water Concentration	1.0 ppb (µg/L) of dissolved PAHs; corresponds to approximately 100 ppb (µg/L) of whole oil (THC) in the water column (soluble PAHs are approximately 1% of the total mass of fresh oil)	Water column effects for both ecological and socioeconomic (e.g., seafood) resources may occur at concentrations exceeding 1 ppb dissolved PAH or 100 ppb whole oil; this threshold is typically used as a screening threshold for potential effects on sensitive organisms.	N/A	Trudel et al (1989); French-McCay (2004); French McCay (2002); French McCay et al (2012)

Threshold Type	Cutoff Threshold	Rationale/Comments (Socioeconomic, Response, Ecological)	Visual Appearance	References
*Thresholds used in supporting stochastic results figures. For comparison, a bacterium is 1-10 µm in size, a strand of spider web silk is 3-8 µm, and paper is 70-80 µm thick. Oil averaging 1 g/m² is approximately equivalent to 1 µm ** Parts per Billion (PPB), Total Hydrocarbon Concentration (THC), and Polycyclic Aromatic Hydrocarbons (PAHs)				

Table 16.6 Defined Ecological and Socioeconomic Thresholds for Oil Related Environmental Effects

Oil Type	Ecological Threshold	Socioeconomic Threshold
Surface Oil	10 g/m^2	0.04 g/m^2
Shoreline Oil	100 g/m^2	1 g/m^2
Water Column Oil	1 ppb dissolved PAH or 100 ppb whole oil.	

16.4.2.2 Deterministic Approach

While the stochastic analysis provides insight into the probable behavior of oil releases given historic meteorological and oceanographic data for the Project Area, the deterministic analysis provides individual trajectory, oil weathering information, expected concentrations or thicknesses of oil contamination, mass balance, or other information related to a single release at a given location and time.

Representative deterministic scenarios (i.e., single trajectory) were identified from each set of stochastic subsurface blowout results. Individual scenarios were selected based upon the size of the surface oil footprint, the mass of oil on shorelines, and the concentration of dissolved hydrocarbons in the water column, based upon a set of highly conservative socioeconomic thresholds:

- Surface oil average thickness >0.04 µm
- Shore oil average concentration >1.0 g/m²
- Subsurface (within the water column) dissolved hydrocarbon concentrations >1.0 µg/L

The selected scenarios included the 95th and 99th percentile runs for surface oil footprint, shoreline oil length, and water column contamination were identified for both release locations when appropriate. Because there was no oil predicted on the shoreline in the 95th percentile case, the 99th percentile scenario for shoreline oil mass was used in the investigation. In addition to these deterministic scenarios, three surface releases of marine diesel were modelled, including two release volumes (100 L and 1,000L) at EL 1144 and a full volume release of a supply vessel fuel tank (750,000 L) between St. John's and the Project Area.

16.4.3 Model Input Data

Geographical data including habitat mapping and shoreline identification and classification were obtained from multiple data sources as summarized in Table 16.7. In addition, the hydrocarbon products that were modelled for this study (marine diesel for the batch spill and the vessel collision and Bay du Nord (BdN) crude oil for the well events) are characterized in Table 16.8.

The physical and chemical data used to characterize these oils were developed by Nexen in consultation with other operators, with additional assays and measurements by S.L. Ross Environmental Research Ltd. (2016) and Petroforma (2013).

BdN is a light crude oil with low viscosity and a high aromatic content (Tables 16.8 and 16.9). The marine diesel modelled is a standard diesel that also has a low viscosity and high content of soluble hydrocarbons. The low viscosity and high soluble content of these oil products provides conservative approximations of anticipated concentrations in the water following a release, as a relatively large proportion of constituents have the potential to dissolve into the water column, when compared to oils with lower soluble content. The physical and chemical parameters of BdN are similar to those of Hibernia crude oil, which was used in previous studies (SL Ross 2016; Environmental Science and Technology Center 2001). These oils would likely behave similarly in the event of a release, with marine diesel being least persistent.

Table 16.7 Model Input Data

Data Type	Data Source	Notes
Oil Type	SL Ross (2016)	BdN Light Crude
Habitat Shoreline	Therrien. (2017) (Canada) NOAA (2016) and MDEP (2016) (US)	
Bathymetry	GEBCO (2003)	
Ice Cover	CIS, ECCC (2017)	206 to 2010 weekly files from Canadian Ice Service
Wind Data	Saha et al. 2010	
Currents	HYCOM	Hybrid Coordinate Ocean Model hindcast and forecast
Water Temperature and Salinities	Levitus et al. (2014)	World Ocean Dataset

Table 16.8 Physical Properties for the Two Oil Products Used in Modelling

Physical Property	BdN Crude Oil	Marine Diesel
Density (g/cm^3)	0.84553 @16°C 0.85800 @0°C	0.83100 @25°C 0.83089 @16°C
Viscosity (cP)	5.0 @20°C 53.0 @0°C	2.76 @25°C 2.76 @15°C
API Gravity	35.85	38.8
Pour Point (°C)	-9	-50
Interface Tension (dyne/cm)	15.5	27.5
Emulsion Maximum Water Content (%)	72	0

Table 16.9 Fraction of the Whole Oil Comprised of Different Distillation Cuts for the Two Oil Products

Distillation Cut[1]	Boiling Point (°C)	Description	BdN Crude Oil	Marine Diesel
AR1	< 180	Highly volatile and soluble monoaromatic hydrocarbons (BTEX[2] and MAHs C6-C9)	0.023739	0.019333
AR2	180 – 264	Semi-volatile and soluble 2-ring aromatics (MAHs and PAHs C10-C12)	0.004166	0.011410
AR3	265 – 380	Low volatility and solubility 3-ring aromatics (PAHs C13-C18)	0.066998	0.015605
AL1	< 180	Highly volatile aliphatics (C4-C8)	0.206261	0.144667
AL2	180 – 280	Semi-volatile aliphatics (C9-C16)	0.160834	0.478690
AL3	280 – 380	Low volatility aliphatics (C17-C23)	0.168002	0.303295
THC1[3]	< 180	Total hydrocarbon fraction 1 (sum of AR1 and AL1)	0.230000	0.164000
THC2	180 – 280	Total hydrocarbon fraction 2 (sum of AR2 and AL2)	0.165000	0.490100
THC3	280 – 380	Total hydrocarbon fraction 3 (sum of AR3 and AL3)	0.235000	0.318900
Residuals	> 380	Aromatics ≥ 4 rings and aliphatics > C20 that are neither volatile nor soluble	0.37000	0.02700

[1]Note that the terms “aromatic” and “aliphatic” are used in a modelling context. “Aromatic” refers to all soluble and volatile hydrocarbons and may include actual aliphatic compounds in the chemical sense that are soluble. In the modelling context, “aliphatic” refers to insoluble and volatile hydrocarbons.
[2]BTEX (benzene, toluene, ethylbenzene, xylene), MAHs (monocylic aromatic hydrocarbons), and PAHs (polycyclic aromatic hydrocarbons) are the more soluble, bioavailable, and potentially toxic components in oil
[3] Note that the total hydrocarbon concentration (THC) is the sum of the aromatic (AR) and aliphatic (AL) groups. Numbers of carbons in the included compounds are listed.

16.4.4 Model Results

The results from both the subsurface blowouts and topside releases presented below illustrate the spatial extent of the water surface and shoreline oil contamination. Stochastic results include:

- The probability footprints for surface oil in excess of 0.04 µm;
- The corresponding minimum time for surface oil to exceed a threshold of 0.04 µm;
- The probability footprints of shoreline oil in excess of 1 g/m²; and
- The corresponding minimum time for surface oil to exceed a threshold of 1 g/m².

The probabilities of oiling were based on a statistical analysis of the ensemble of individual trajectories modelled for each release scenario. Stochastic figures again do not imply that the entire contoured area would be covered with oil in the event of a release, nor do they provide any specific information on the quantity of oil in a given area. Rather, these figures denote the probability of oil exceeding

socioeconomic effects thresholds over all stochastic runs (119 individual releases for the annual scenario), at all modelled time steps (over 60 days), and for each point within the modelled domain. Note that only probabilities of greater than or equal to one percent were included in the map output.

16.4.4.1 Summary of Stochastic Results

A total of 119 individual model runs were conducted for the statistical analysis for each modelled release at the EL 1144 and EL 1150 hypothetical release sites, representing subsurface blowouts (30-day) in waters offshore of Newfoundland. Two 30-day releases were modelled at the EL 1144 (1,137 m water depth) and EL 1150 (378 m water depth) example well sites to represent cap-and-stack response scenarios, and were modelled for a total of 60 days. Figures with the largest areas (Table 16.10, summer runs for surface and water column contamination, winter run for shoreline oil) are presented in this section, but details on all runs are available in Appendix G.

Summaries of the stochastic analyses of potential surface oil exposure and water column contamination by dissolved hydrocarbons depict areas with the highest potential likelihood (over 90 percent) to exceed thresholds primarily to the east and south of the release sites. Much lower probabilities of threshold exceedance are predicted to the north and east (generally less than 25 percent) (Figures 16.11 to 16.17). Releases were predicted to have potential effects on Canadian and international waters. In many cases, oil contamination above the identified threshold was predicted to extend beyond the extent of the model domain to the east and south. In these scenarios, the environmental forcing mechanisms (i.e., wind and currents) and long timeframe modelled (60 days) allowed for the transport of highly weathered oil (greater than 50 days old) outside of the model domain.

The hypothetical 30 day release at EL 1144 example well site was predicted to lead to a larger stochastic surface oil probability footprint, where oil may exceed the 0.04 µm thickness threshold in over one percent of releases, when compared to the release at EL 1150 example well site (Table 16.10) due to the larger release volume (5,520,000 bbl at EL 1144 vs. 1,329,000 bbl at EL 1150). The over 90 percent probability footprints threshold exceedances were predicted to extend to the south and east of EL 1144 example well site approximately 300-600 km for surface oil and 800-1,200 km for in water contamination (Figures 16.11 to 16.13). For EL 1150, the surface oil extents were closer to 200-400 km and in water contamination closer to 400-800 km (Figure 16.14 to 16.17). Predicted threshold exceedance footprints were typically similar in size for each release location between seasons, however the surface oil exceedance was larger in the summer, due to calmer winds resulting in less entrainment and therefore more surface oil (Table 16.10). The larger release volume at EL 1144 example well site resulted in larger surface oil and in water contamination predictions than EL 1150 example well site. EL 1144 is located closer to shore than EL 1150 and was therefore predicted to result in a very small probability (less than three percent) of shoreline oil contamination at Sable Island within 60 days (Table 16.11; Figure 16.13). Releases at EL 1150 example well site were not predicted to make contact with the shore (Figures 16.16 to 16.17).

In general, model results were very similar for EL 1144 example well site, when compared to EL 1150 example well site, especially for the lowest probability contours. However, the hypothetical releases at the EL 1144 example wells site were deeper, farther offshore, and had a release volume that was over four times larger than those at EL 1150 example well site, resulting in much larger predicted areas for the 10 percent and 90 percent likelihood of threshold exceedance (Table 16.10).

As stated previously, stochastic figures do not imply that the entire contoured area would be covered with oil in the event of a single release, nor do they provide any information on the quantity of oil in each area. The large threshold exceedance footprints in annual results are not the expected exposure from any single release of oil, but rather areas where there is over one percent probability that exposure above the threshold could occur, based on the combination of either 119 (annual), 60 (summer), or 59 (winter) individual releases analyzed together.

Any oil that was predicted to make contact with shorelines would be expected to be highly weathered, as minimum time estimates for first shoreline oil exposure ranged from approximately 52-53 days (Table 16.11). The oil that did make its way to shore would therefore likely be patchy and discontinuous. Oil from the subsurface releases was transported by subsurface currents, which had a higher potential to transport subsurface oil to the west and southwest prior to surfacing than did surface currents.

Table 16.10 Predicted Areas Exceeding the Identified Thresholds for Surface Oil Thickness, Water Column Concentration, and Mass per Unit Area on Shorelines for the EL 1144 and EL 1150 Example Well Sites

Stochastic Scenario Parameters				Areas Exceeding Threshold (km^2)		
Component and Threshold	**Scenario**	**Example Well Site**	**Probability Contour or Bin**	**Annual Results**	**Winter (ice cover)**	**Summer (ice-free)**
Surface Oil > 0.04 µm, on average	30-day release	EL 1144 (184,000 bpd)	1%	1,942,000	2,102,000	1,927,000
			10%	1,140,000	1,115,000	1,145,000
			90%	56,100	24,750	128,300
		EL 1150 (44,291 bpd)	1%	1,783,000	1,945,000	1,776,000
			10%	849,200	789,900	899,300
			90%	16,750	10,180	51,470
Water Column Dissolved Hydrocarbons > 1 µg/L at some depth within the water column	30-day release	EL 1144 (184,000 bpd)	1%	223,600	215,100	2,346,000
			10%	162,000	171,900	1,513,000
			90%	32,950	26,810	456,000
		EL 1150 (44,291 bpd)	1%	210,100	225,000	203,500
			10%	146,000	155,800	136,200
			90%	18,550	10,610	28,790
Shoreline Oil > 1 g/m^2, on average	30-day release	EL 1144 (184,000 bpd)	1 - 5%	9	18	-
			5 - 15%	-	-	-
			15 - 35%	-	-	-
		EL 1150 (44,291 bpd)	1 - 5%	-	-	-
			5 - 15%	-	-	-
			15 - 35%	-	-	-
Bins are based on stochastic probabilities; for example, 56,100 km^2 of the ocean surface exceeded the 0.04 µm surface oil threshold in 90% of the 119 modelled simulations over the entire modelled duration						

Table 16.11 Shoreline Contamination Probabilities and Minimum Time for Oil Exposure Exceeding 1 g/m2

Scenario	Example Well Release Site	Scenario Timeframe	Average Probability of Shoreline Oil Contamination (%)	Maximum Probability of Shoreline Oil Contamination (%)	Minimum Time to Shore (days)	Maximum Time to Shore (days)
30-day release	EL 1144 (184,000 bpd)	Annual	2	2	52	54
		Winter	2.5	3	53	54
		Summer	-	-	-	-
	EL 1150 (44,291 bpd)	Annual	-	-	-	-
		Winter	-	-	-	-
		Summer	-	-	-	-

Figure 16.11 Summer Probability of Average Surface Oil Thickness >0.04 µm (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Pass EL 1144 Well Site.

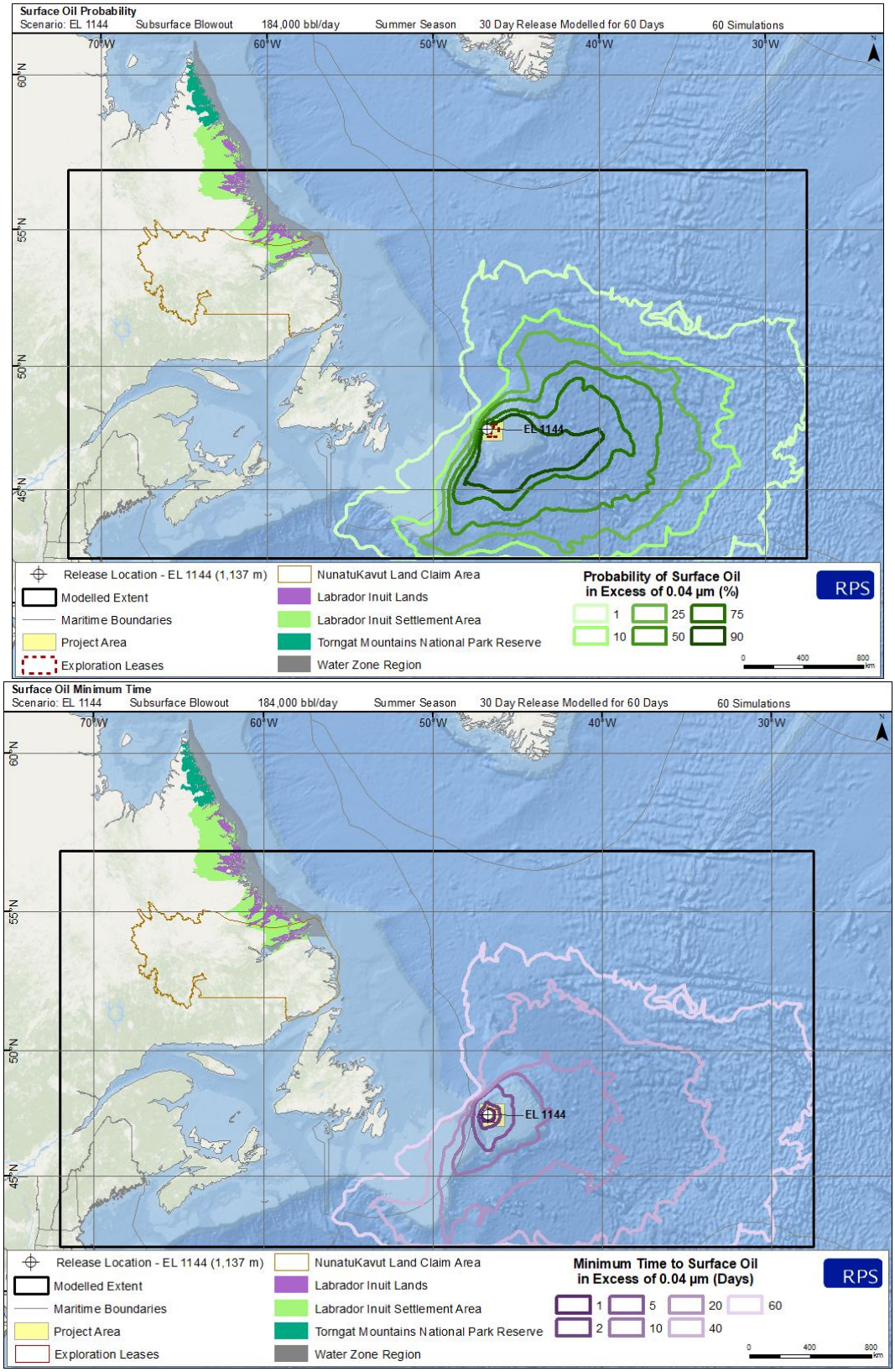


Figure 16.12 Summer Probability of Dissolved Hydrocarbon Concentrations >1 µg/L at Some Depth in the Water Column (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Pass EL 1144 Example Well Site

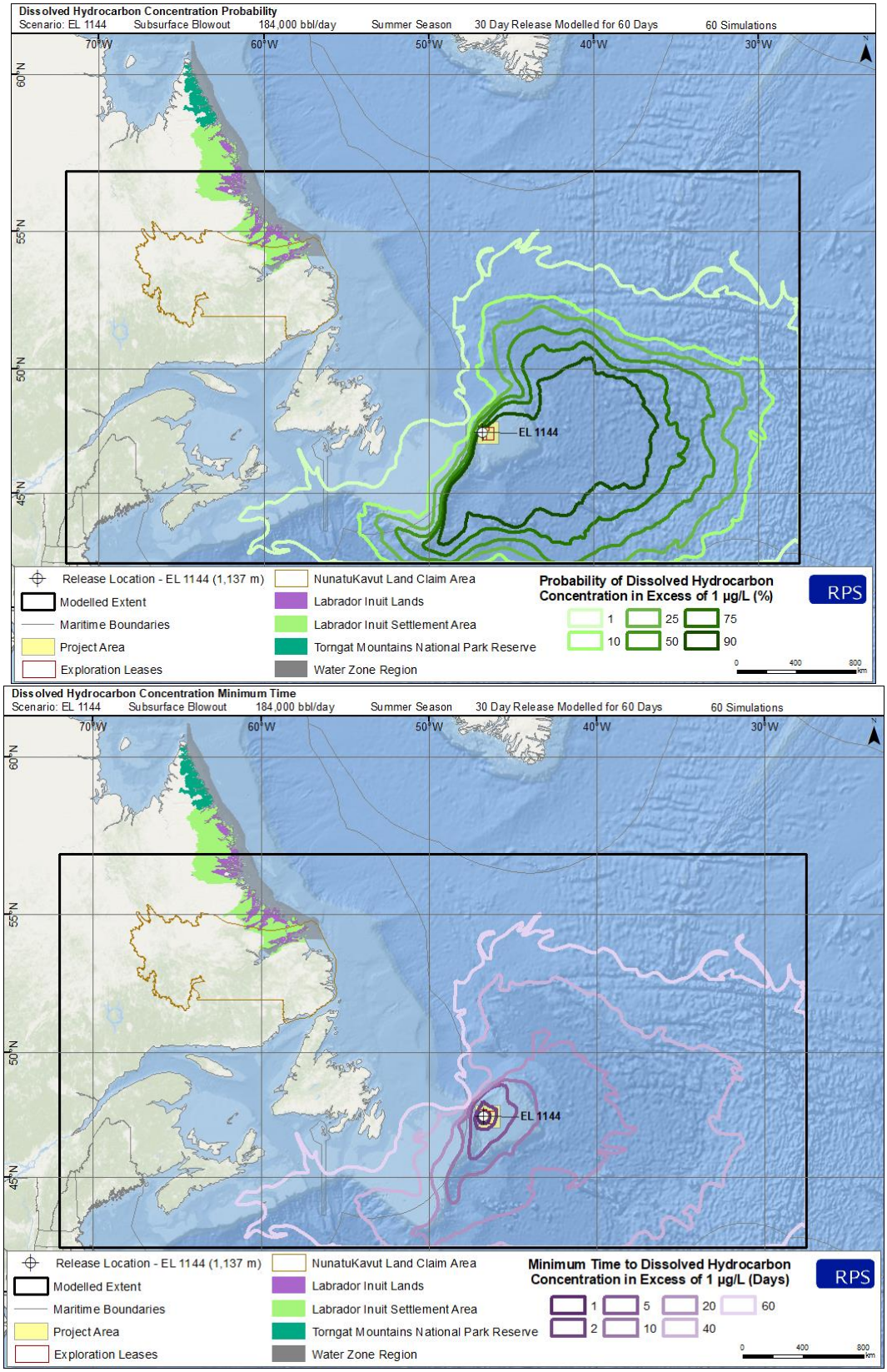


Figure 16.13 Summer Probability of Shoreline Contact >1 G/M² (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Pass EL 1144 Example Well Site

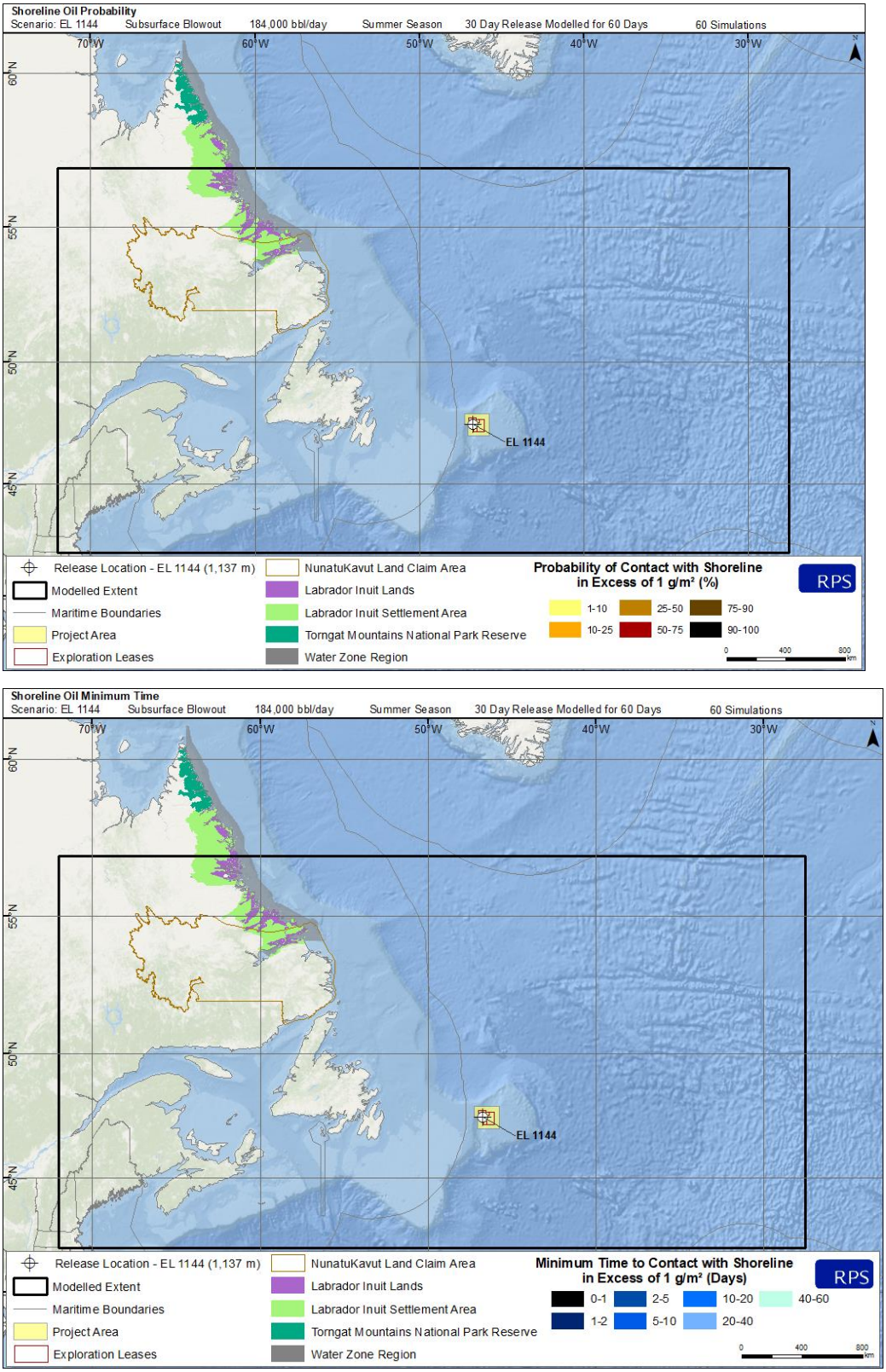


Figure 16.14 Summer Probability of Average Surface Oil Thickness >0.04 µm (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at The Flemish Cap EL 1150 Example Well Site

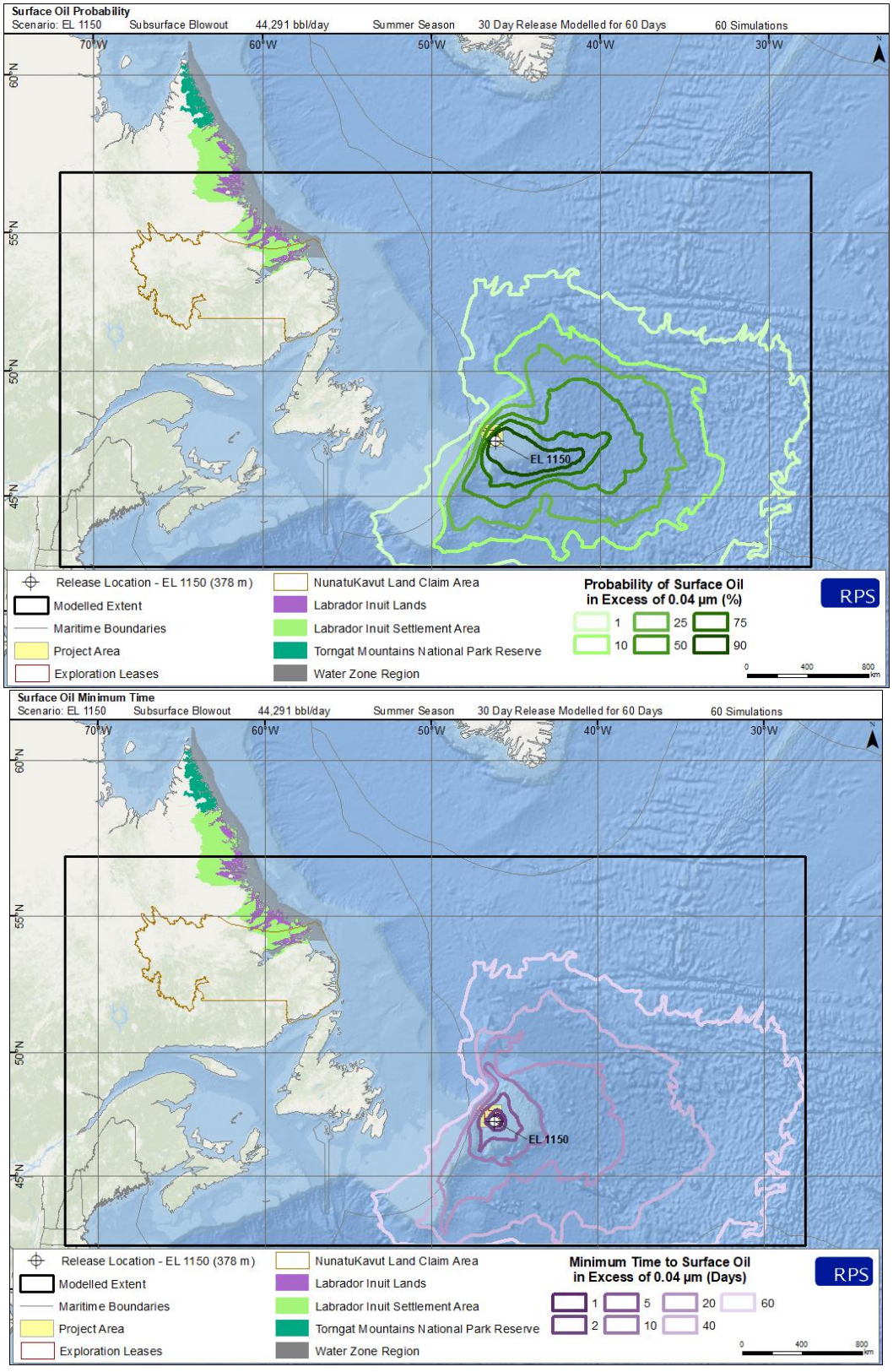


Figure 16.15 Summer Probability of Dissolved Hydrocarbon Concentrations >1 µg/L at Some Depth in the Water Column (Top) And Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Cap EL 1150 Example Well Site

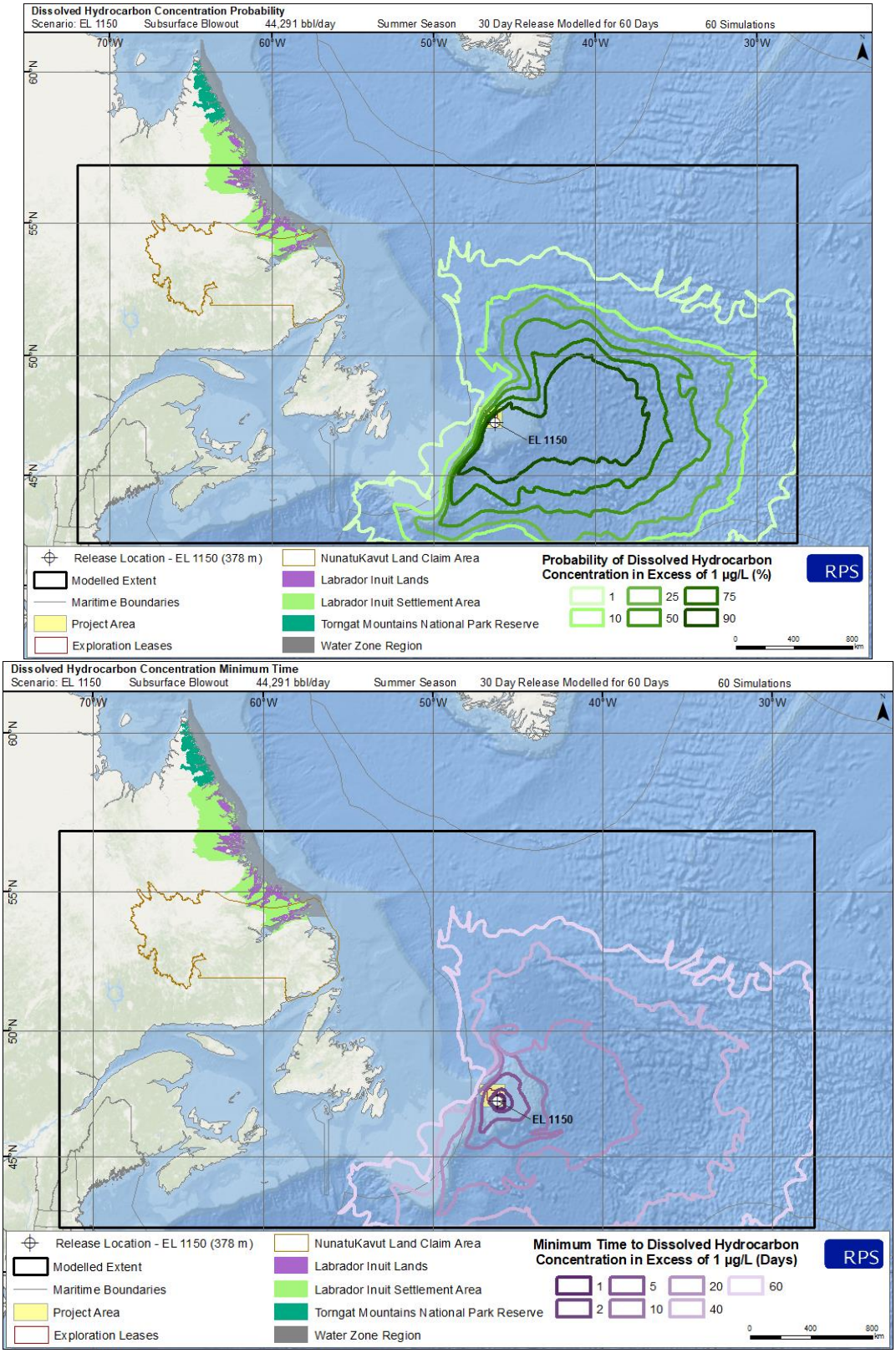
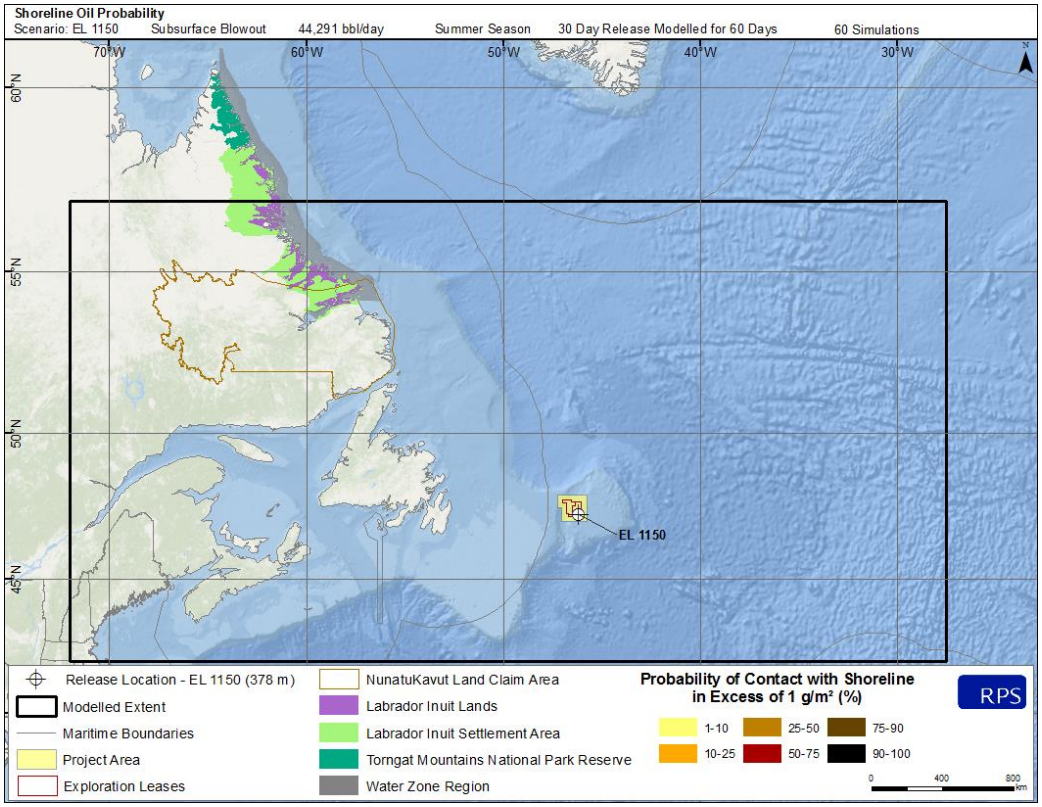


Figure 16.16 Summer Probability of Shoreline Contact >1 G/M² (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Cap EL 1150 Example Well Site



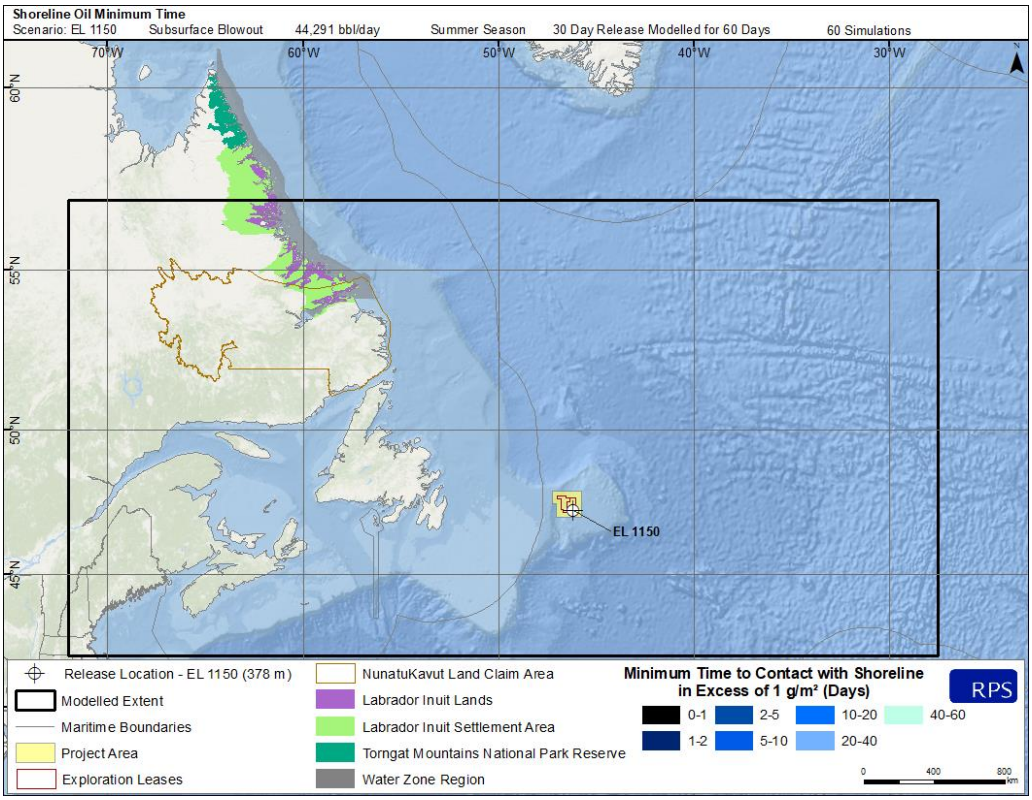
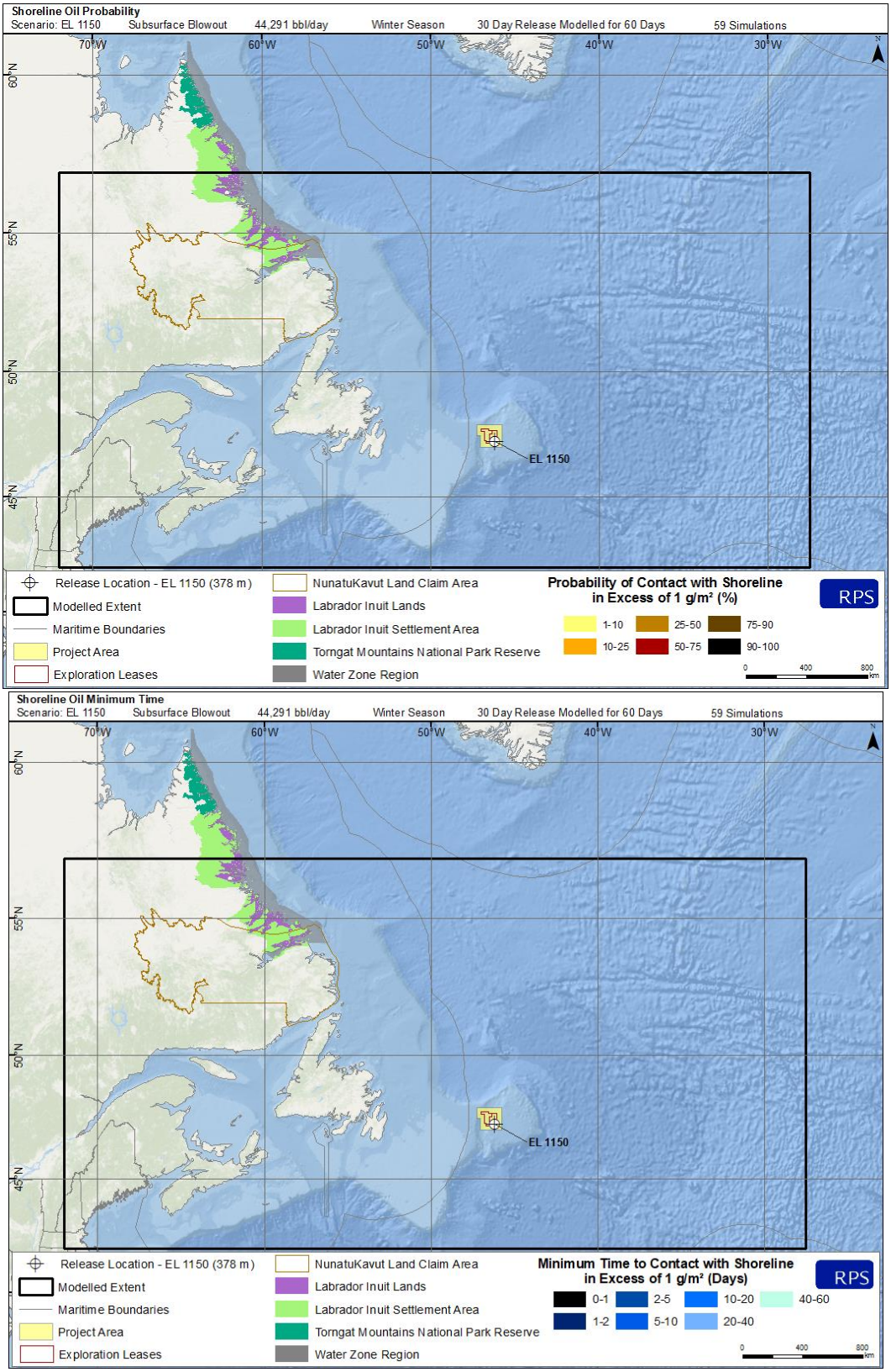


Figure 16.17 Winter Probability of Shoreline Contact >1 G/M² (Top) and Minimum Time to Threshold Exceedance (Bottom) Resulting from a Subsurface Blowout at the Flemish Cap EL 1150 Example Well Site



16.4.4.2 Summary of Deterministic Results

For all representative deterministic scenarios, the majority of the surface oil (94-99 percent) was predicted to either entrain, evaporate, or degrade by the end of the simulation, with less than 1-6 percent predicted to remain on the surface after 60 days (Table 16.11). For the marine diesel releases, less than 0.01 percent of marine diesel was predicted to remain on the surface after 30 days. This high volatility and solubility of the oil and marine diesel facilitated the large amount of predicted evaporation to the atmosphere (35-42 percent for oil and 40-76 percent for diesel) and dissolution into and degradation within the water column (32-38 percent for oil and 16-45 percent for diesel). Predicted entrained oil in the water column ranged between 20 percent and 27 percent for the blowouts of oil and 8-14 percent for the marine diesel releases after 30 and 60 days, respectively. Shoreline oiling was not predicted for approximately 97 percent of the modelled blowout simulations. As predicted in the 99th percentile shoreline contact case, less than 0.01 percent of the released oil reached the shores of Sable Island after more than 50 days. In each case, oil on the sediments was predicted to be extremely limited, with less than 0.02 percent of the release making its way to the bottom. In many simulations, some portion of the released oil mass was predicted to travel outside of the model domain, in some cases up to two percent.

The maximum subsurface water volume exposed to THC concentrations above 1 µg/L for the two 95th percentile water column cases are comparable to one another, with 58,842 km^3 predicted for EL 1144 example well site and 54,943 km^3 predicted for EL 1150 example well site. This volume is comparable to the predicted areal footprints of contamination for surface oil down to mixed layer depths (tens of meters). For the 95th percentile water column contamination cases at EL 1144 example well site, the region that may experience concentrations >200 µg/L for dissolved hydrocarbons at any point over the 60-day simulation was predicted primarily within 200 km to the southeast and north of the release site. At the EL 1150 example well site, dissolved hydrocarbon concentrations of over 200 µg/L were found to the southeast of the release within approximately 150 km. Entrained oil concentrations in surface waters were predicted to vary considerably from day to day, as would be expected due to the dependence on variable wind induced surface breaking wave formation.

The 99th percentile shoreline exposure case was identified for EL 1144 example well site rather than the 95th percentile, as no shoreline oiling was predicted for the 95th percentile case. For EL 1150 example wells site, there was no scenario that resulted in shoreline exposure within 60 days. The predicted (but unlikely) shoreline oiling from the release at EL 1144 example well site was predicted to occur at Sable Island (Figure 16.13). The area of shore where shoreline oil exceeded the 1 g/m^2 threshold was predicted to be approximately 13 km^2. However, shoreline oil was predicted to comprise an extremely small portion of the total mass of released oil (less than 0.01 percent) in this case.

Surface Oil Exposure Cases

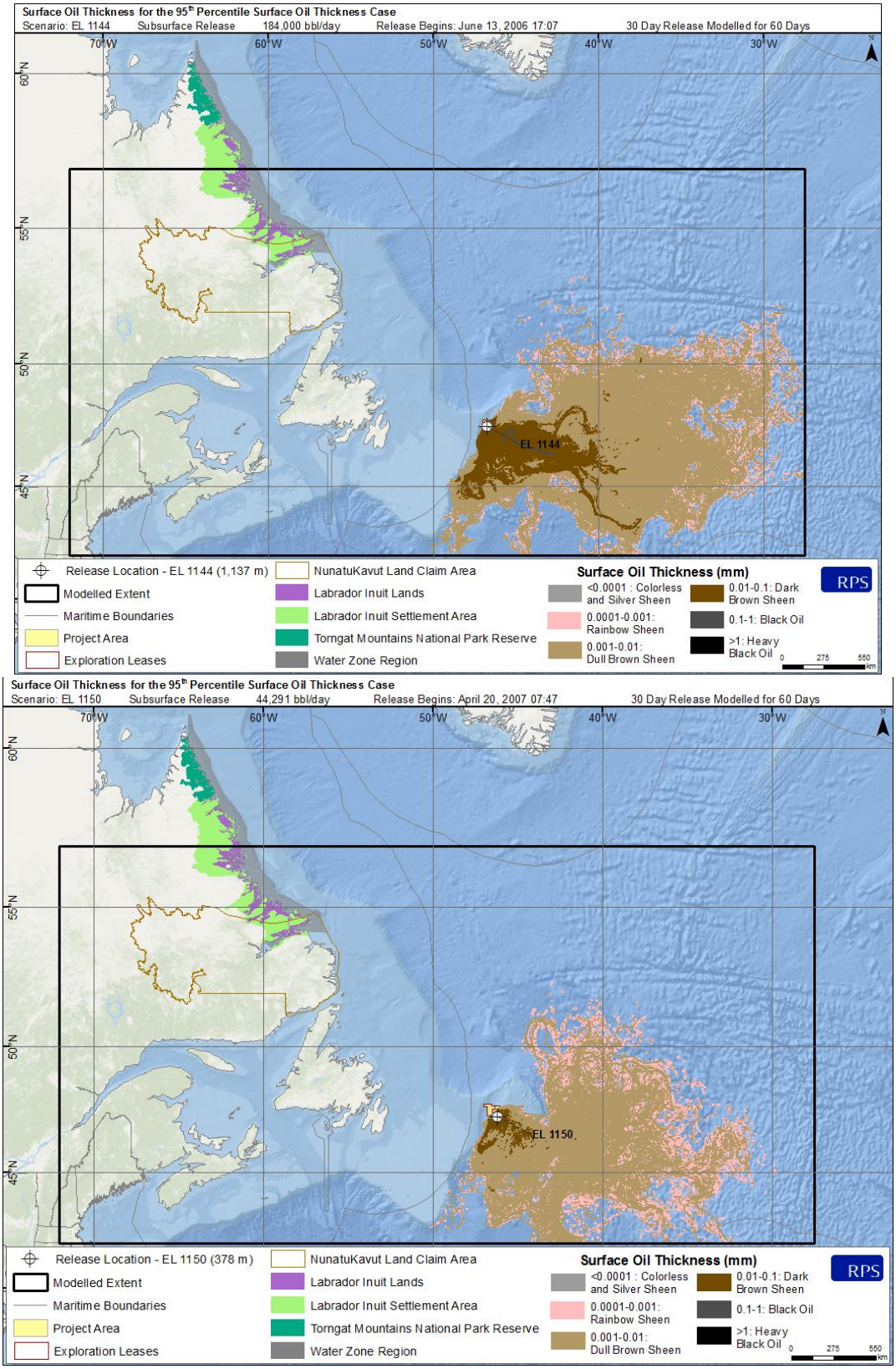
For surface oil, both the 95th percentile release cases at EL 1144 and EL 1150 example well sites occurred during the summer season (defined as ice-free for more than half the days of the model run) where wind speeds were sufficiently low to prevent entrainment and allow for more extensive surface slicks. The 99th percentile shoreline oiling case was identified in the late summer, where weather patterns were sufficient to transport oil to the south and west, where a small fraction of oil (less than 0.01 percent) was transported to the shores of Sable Island. For the 95th percentile water column contamination cases, scenarios were always during winter months, where high wind speeds were

sufficient to generate surface breaking waves with entrained surface oil and resulted in the largest amounts of oil in the water column. For the representative “batch spills” and vessel collision, low wind speed periods were identified for each of the three scenarios which occurred during the summer.

The depth of release and the total release volume affected results for the subsurface blowouts. EL 1150 example well site was the shallower of the two sites (378 m), which contributed to faster surfacing of subsurface oil. However, even though the release at EL 1144 example well site was much deeper (1,137 m), the much larger release volume (over four times that of EL 1150) was predicted to result in thicker surface area over broader areas. There were some limited areas with the potential for black oil (0.1 – 1 mm) at distances greater than 10 km from the release point and a greater areal extent of dark brown sheens (0.01-0.1 mm). For releases at EL 1150, surface thicknesses were predicted to be closer to dark brown sheens away from the release point over a smaller area due to the smaller release volume (Figure 16.18).

For all representative deterministic scenarios, the majority of the surface oil (94-99 percent) was predicted to either entrain, evaporate, or degrade by the end of the simulation, with less than 1-6 percent predicted to remain on the surface after 60 days. For the marine diesel releases, less than 0.01 percent of marine diesel was predicted to remain on the surface after 30 days. This high volatility and solubility of the oil and marine diesel facilitated the large amount of predicted evaporation to the atmosphere (35-42 percent for oil and 40-76 percent for diesel) and dissolution into and degradation within the water column (32-38 percent for oil and 16-45 percent for diesel). Predicted entrained oil in the water column ranged between 20 percent and 27 percent for the blowouts of BdN and 8-14 percent for the marine diesel releases after 30 and 60 days, respectively.

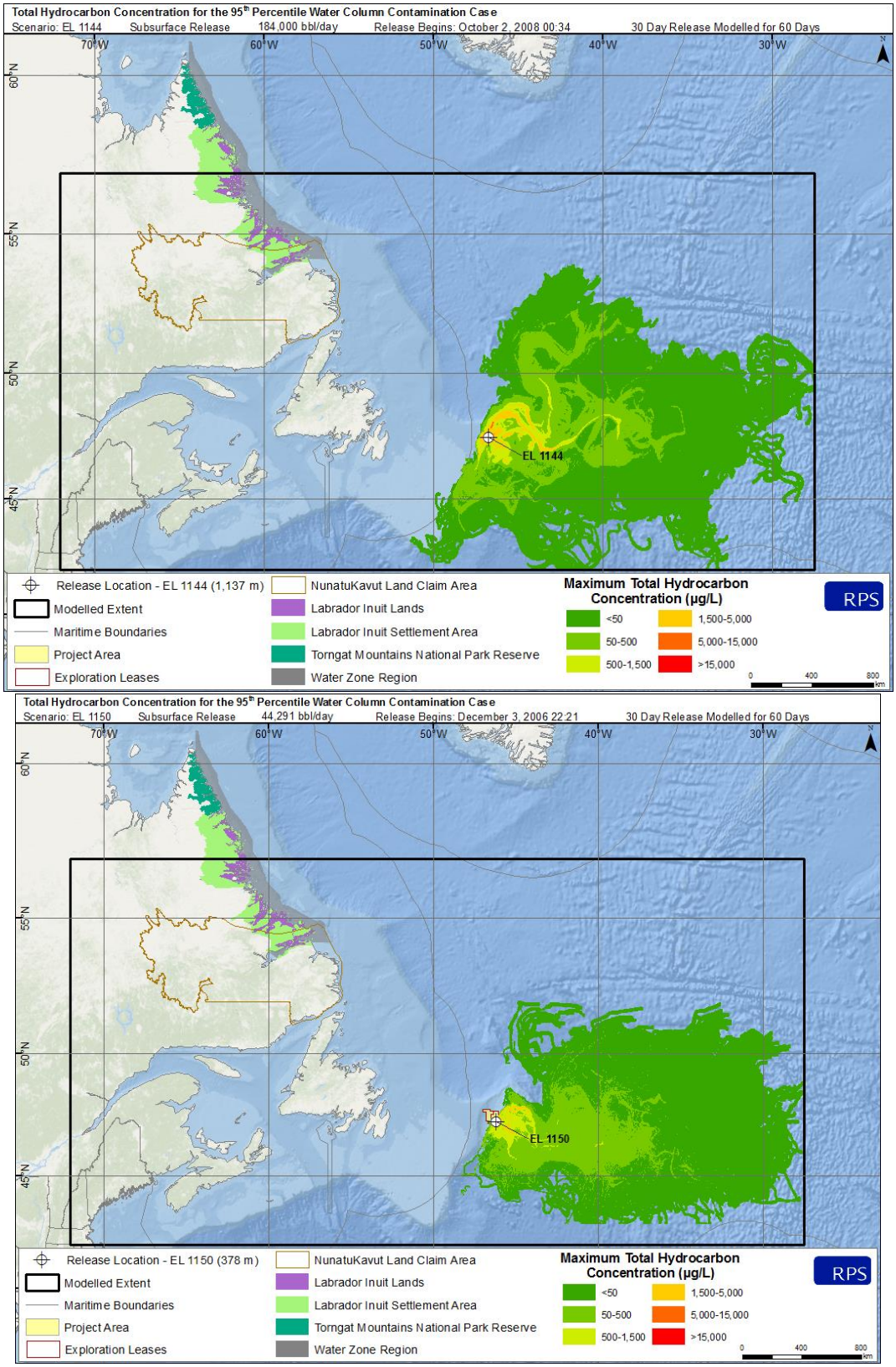
Figure 16.18 Representative Scenario for 95th Percentile Average Surface Oil Thickness Resulting from A 30-Day Subsurface Blowout at EL 1144 (Top) and the EL 1150 (Bottom) Example Well Sites.



Water Column Exposure Cases

The maximum subsurface water volume exposed to THC concentrations above 1 µg/L for the two 95th percentile water column cases are comparable to one another, with 58,842 km^3 predicted for EL 1144 example well site and 54,943 km^3 predicted for EL 1150 example well site (Figure 16.19). This volume is comparable to the predicted areal footprints of contamination for surface oil down to mixed layer depths (tens of meters). For the 95th percentile water column contamination cases at EL 1144, the region that may experience concentrations of over 200 µg/L for dissolved hydrocarbons at any point over the 60-day simulation was predicted primarily within 200 km to the southeast and north of the release site. At EL 1150, dissolved hydrocarbon concentrations of over 200 µg/L were found to the southeast of the release within approximately 150 km. Entrained oil concentrations in surface waters were predicted to vary considerably from day to day, as would be expected due to the dependence on variable wind induced surface breaking wave formation.

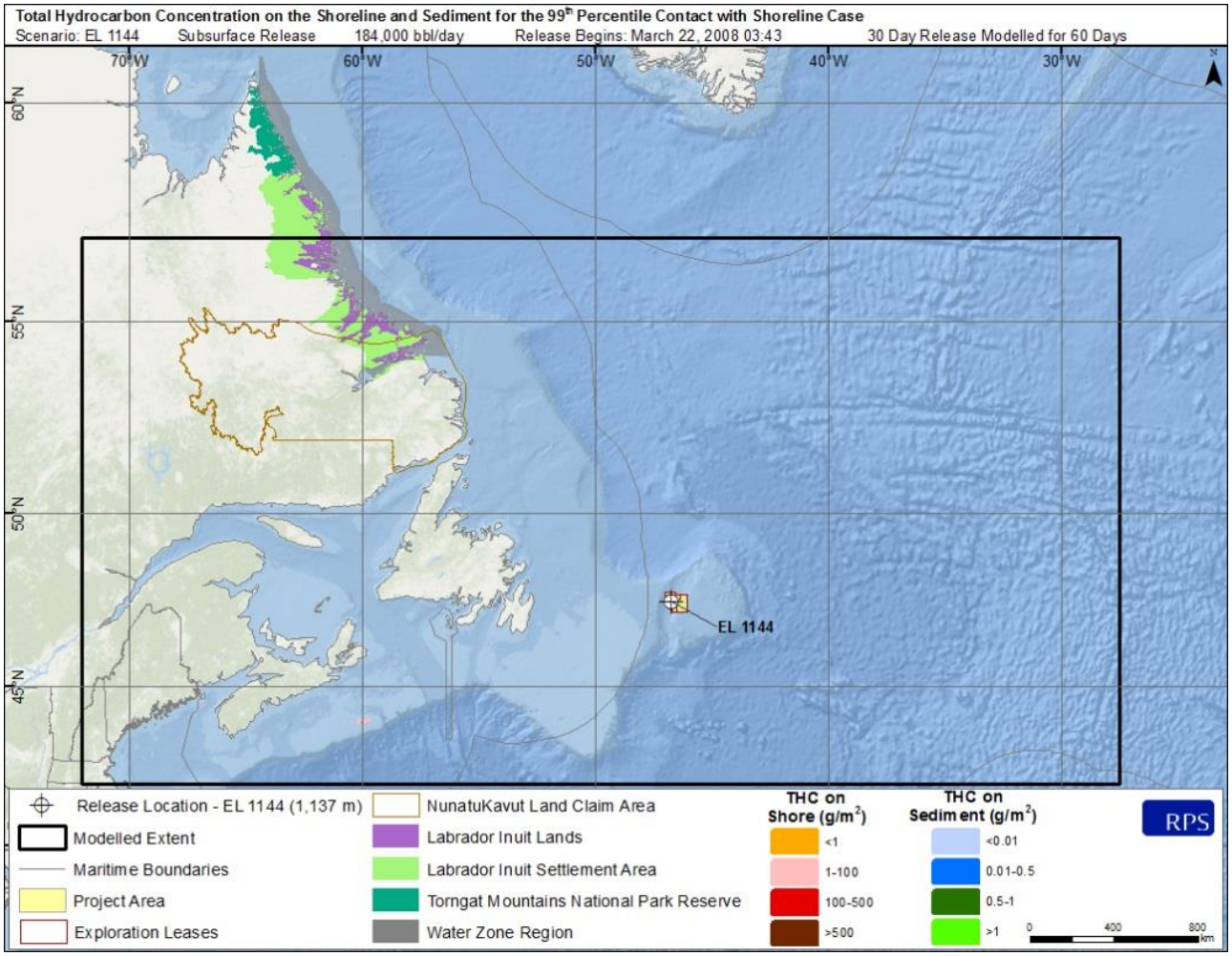
Figure 16.19 Maximum Total Hydrocarbon Concentration (THC) at Any Depth in the Water Column for the 95th Percentile Water Column Contamination Case Resulting from a 30-Day Subsurface Blowout at EL 1144 (Top) and EL 1150 (Bottom) Example Well Sites.



Shoreline Exposure Case

The 99th percentile shoreline exposure case was identified for EL 1144 example well site rather than the 95th percentile, as no shoreline oiling was predicted for the 95th percentile case. For EL 1150 example well site, there was no scenario that resulted in shoreline exposure within 60 days. The predicted shoreline oiling from the release at EL 1144 example well site was predicted to occur on Sable Island (Figure 16.20). The area of shore where shoreline oil exceeded the 1 g/m^2 threshold was predicted to be approximately 13 km^2. However, shoreline oil was predicted to comprise an extremely small portion of the total mass of released oil (less than 0.01 percent) in this case.

Figure 16.20 THC on the Shore and Sediment for the 99th Percentile Contact with Shoreline Case Resulting from a 30-Day Subsurface Blowout at EL 1150 Example Well Sites



16.4.4.3 Marine Diesel Batch Spills

For the “batch spill” releases of marine diesel, mass balance predictions portray the rapid entrainment of a large portion (30-45 percent) of surface oil within several hours of the release (Figure 16.21). After 24 hours, 52-66 percent was predicted to evaporate, with less than three percent remaining on the surface. Some of the entrained oil was predicted to resurface within a day or two, however by day seven nearly all the surface oil was either evaporated, entrained, or degraded.

For the hypothetical vessel collision release, a large portion (approximately 80 percent) of the oil was predicted to entrain within the first two days. More quiescent conditions resulted in the resurfacing of approximately five percent of the released oil and rapid evaporation of approximately 40 percent. On day eight, another wind event resulted in the complete entrainment of the surface oil and mixing within the water column, which reduced the amount of evaporation and resulted in degradation being a major fate pathway for this release, accounting for approximately 45 percent of the release volume. For all three batch spill cases, less than 0.01 percent of oil was predicted to remain on the surface by the end of the 30-day simulation, with a significant portion evaporated (40-76 percent), a portion in the water column (8-14 percent), and the rest degraded (16-45 percent). No shoreline oiling and negligible oil on the sediments was predicted.

For the small volume “batch spills” modelled at EL 1144 example well site, patchy and discontinuous colorless and silver sheens <0.0001 mm (0.1 µm) were predicted over limited distances (Figure 16.22). The cumulative area of average surface oil thickness >0.04 µm was <1 km^2 for the 100 L release and approximately eight km^2 for the 1,000 L release. Total hydrocarbon concentrations were not predicted to exceed 1 µg/L for the 100 L release and the vertical maximum THC concentrations for the 1,000 L release were only predicted to reached 2 µg/L within about five km of the release site. Note that water column contamination for the marine batch release cases was reported as THC, as opposed to dissolved hydrocarbons reported for the other deterministic and stochastic scenarios, as release volumes were insufficient to create reportable concentrations.

Figure 16.21 Mass Balance Plots of the EL 1144 Example Well Site Release of Marine Diesel From Batch Spills of 100 L (Top) and 1,000 L (Bottom)

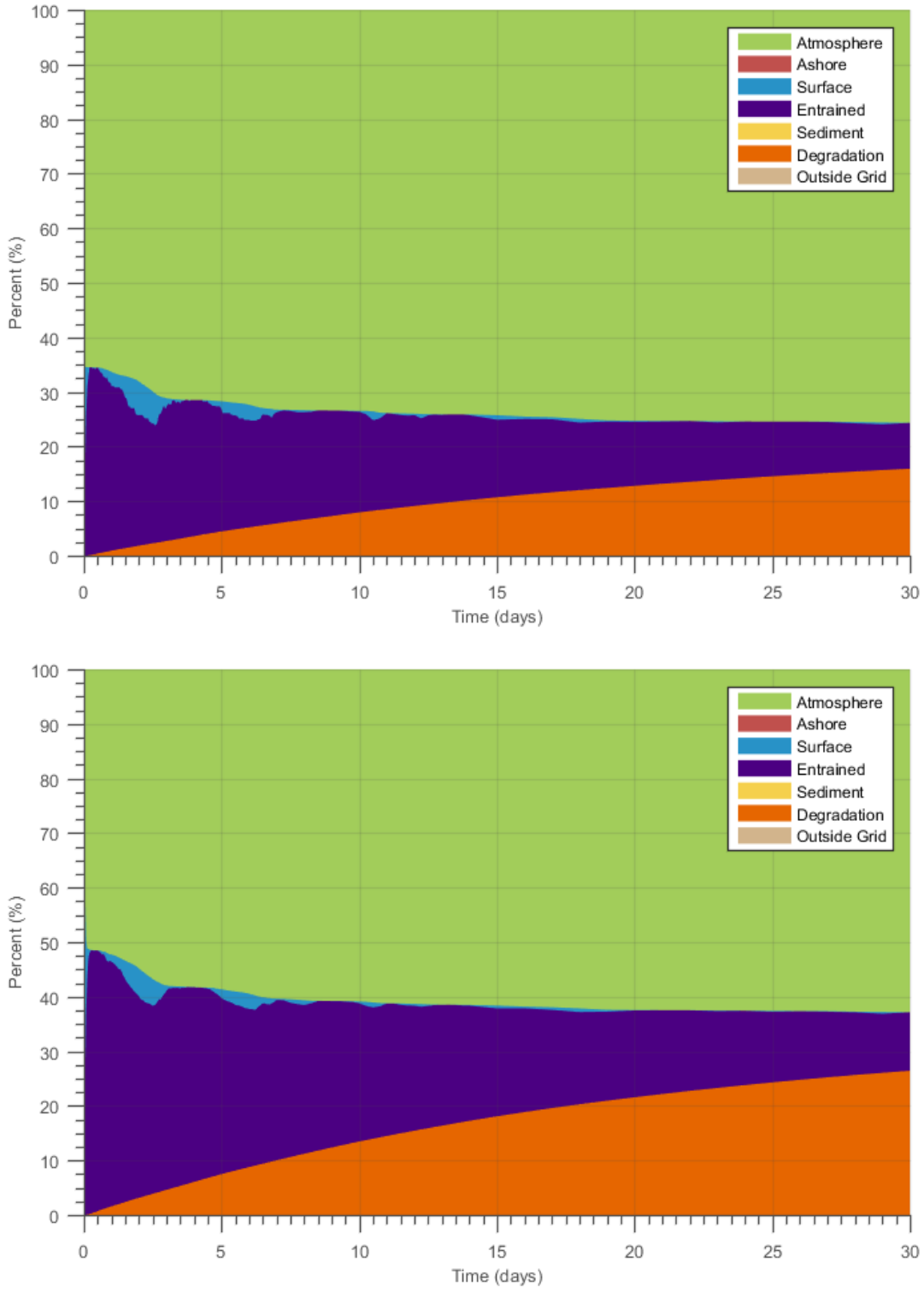
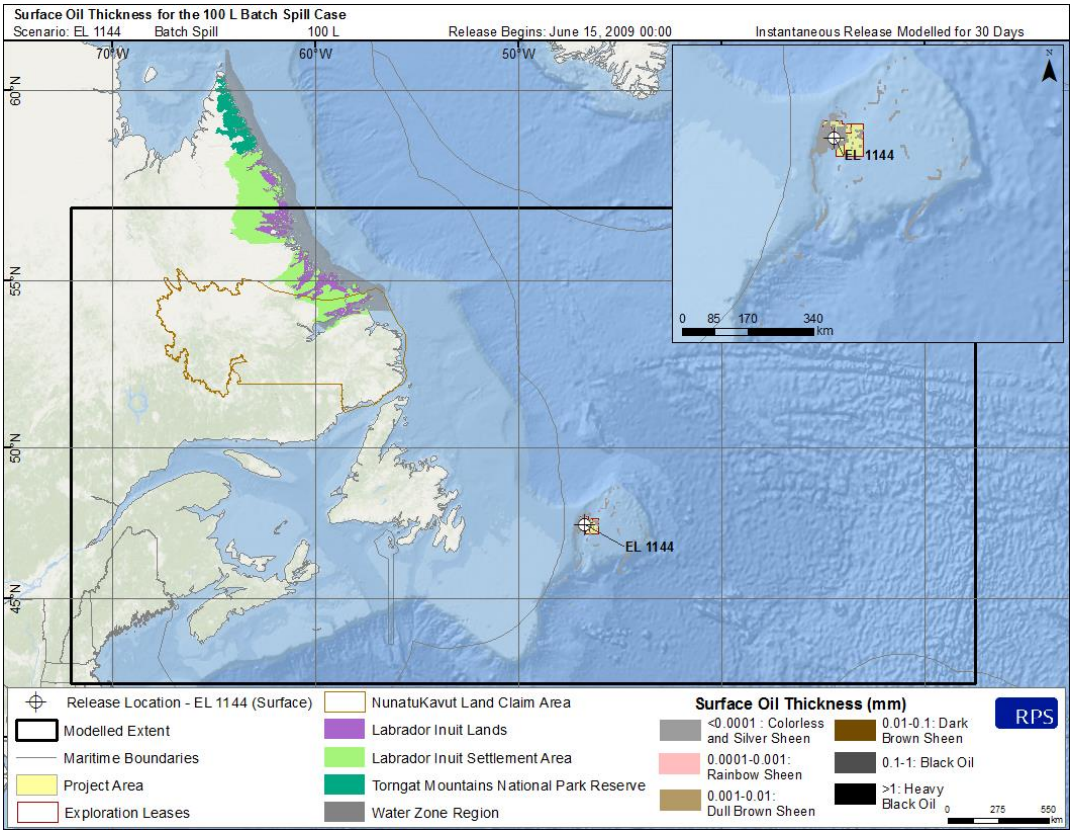
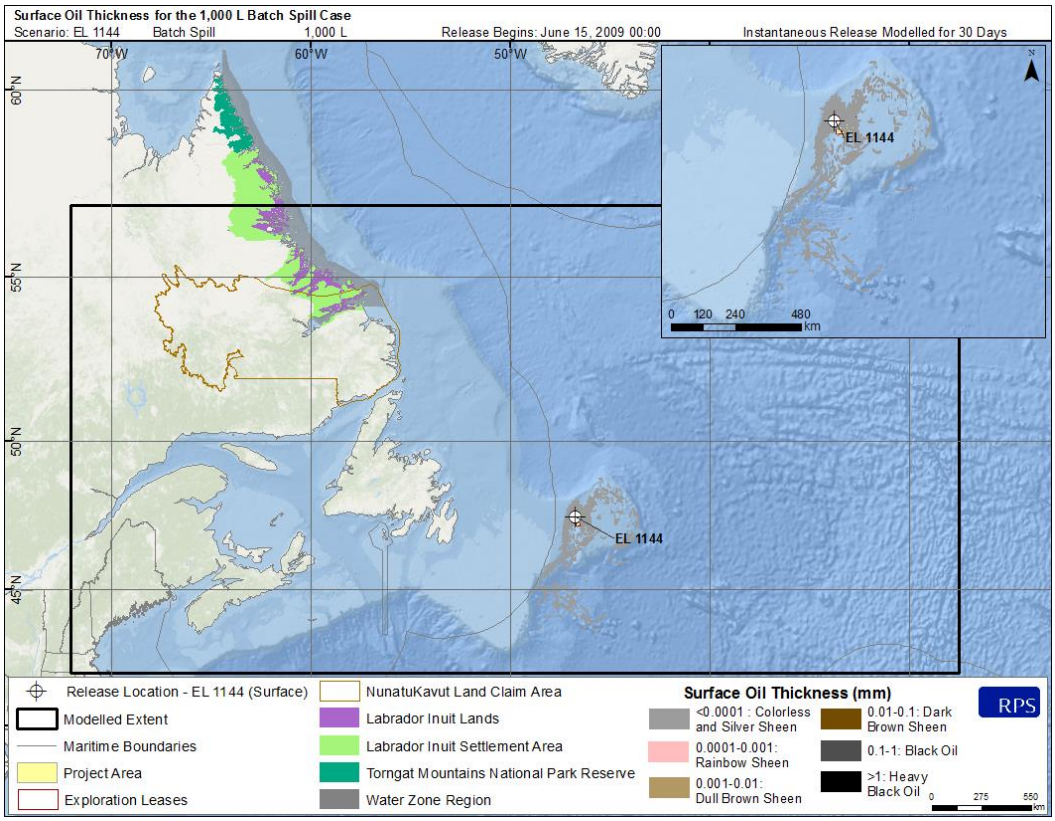


Figure 16.22 Surface Oil Thickness Resulting from the EL 1144 Example Well Site Release of Marine Diesel from Batch Spills of 100 L (Top) and 1,000 L (Bottom)





16.4.4.4 Vessel Collision Scenario

The hypothetical (and unlikely) 750,000 L spill from a vessel collision was predicted to result in more extensive surface oil and a smaller percentage of oil evaporating (Figure 16.23), when compared to the modelled “batch spills.” The release would be predicted to result in patchy and discontinuous surface sheens, although the large release volume would likely result in a rainbow sheen for approximately 40 km before transitioning to the colorless and silver sheen that was predicted for the “batch spills.” The predicted exposure area for surface oil from the vessel collision was 925 km^2 for the lower 0.04 µm socioeconomic threshold and 13 km^2 for the higher 10 µm ecological threshold (Figure 16.24).

Figure 16.23 Mass Balance Plots of the VCL Release Site of Marine Diesel from the Vessel Collision Release of 750,000 L

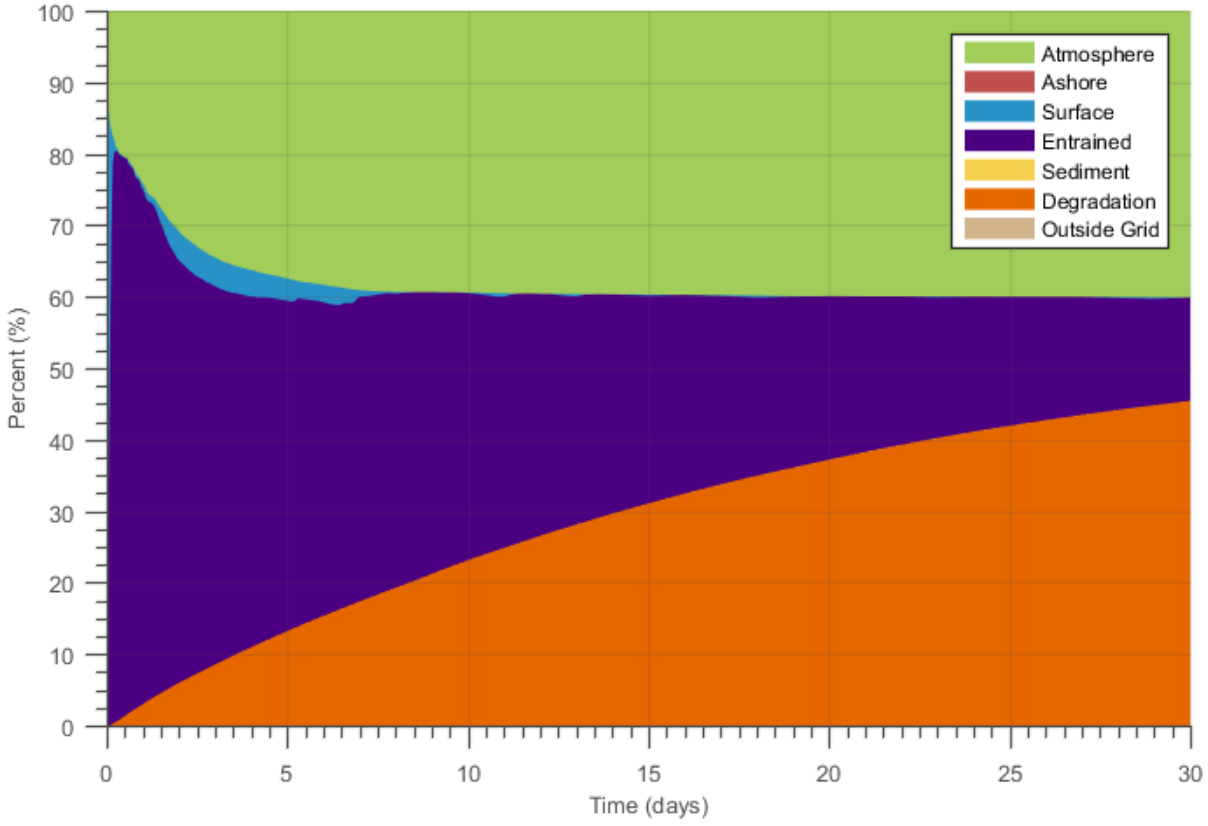
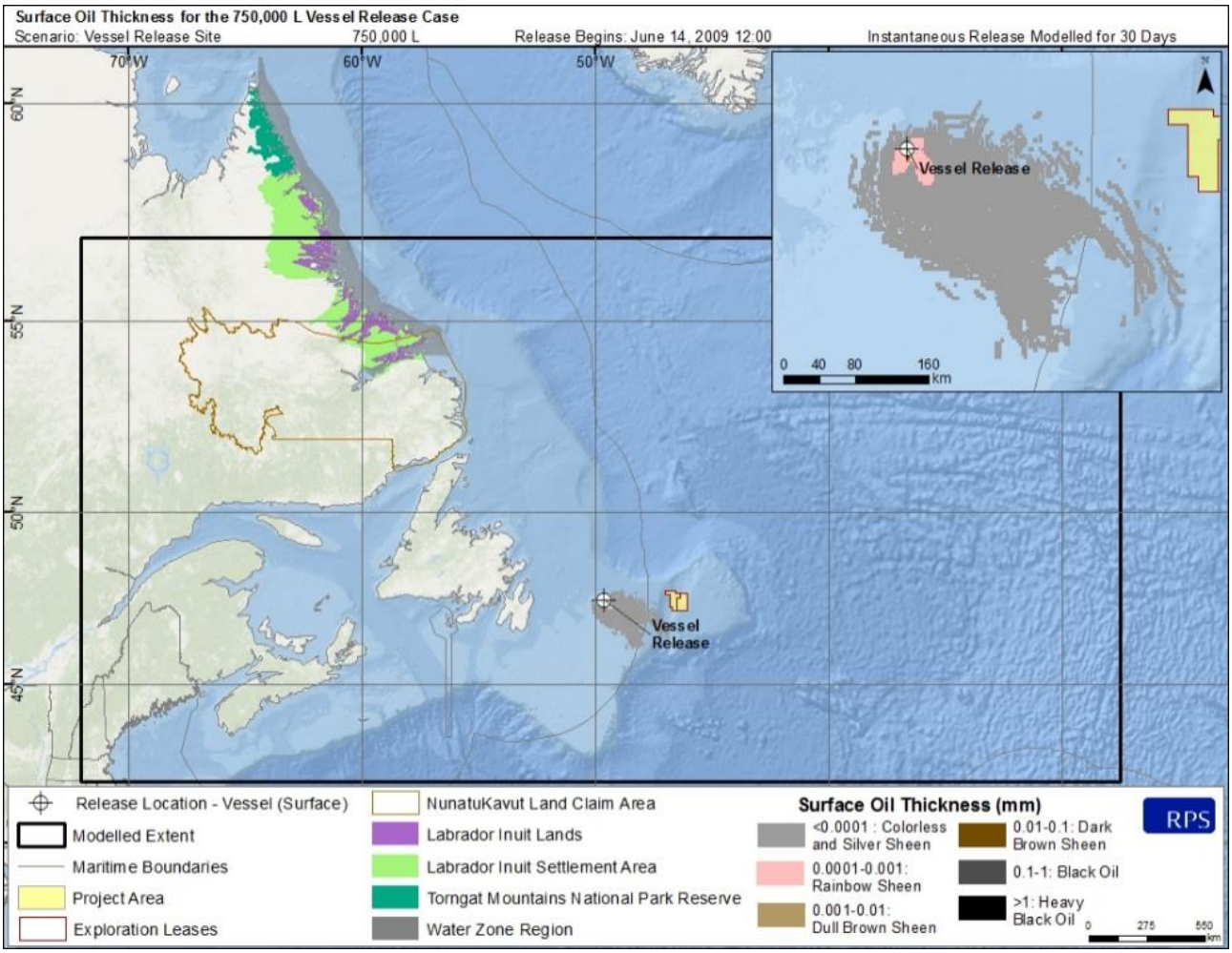


Figure 16.24 Surface Oil Thickness Resulting from the VCL Release of Marine Diesel from the Vessel Collision Release of 750,000 L



16.4.4.5 Key Uncertainties

The SIMAP model has been developed over several decades to include past and recent information from laboratory based experiments and real-world releases to simulate the trajectory and fate of discharged oil. However, there are limits to the complexity of processes that can be modelled, as well as gaps in knowledge regarding the affected environment. Assumptions based on available scientific information and professional judgment were made in the development of the model, which represent a best assessment of the processes and potential exposures that could result from oil releases.

The major sources of uncertainty in the oil fate model is:

- Oil contains thousands of chemicals with differing physical and chemical properties that determine their fate in the environment. The model must, out of necessity, treat the oil as a mixture of a limited number of components, grouping chemicals by physical and chemical properties.

- The fates model contains a series of algorithms that are simplifications of complex physical-chemical processes. These processes are understood to varying degrees.

- The model treats each release as an isolated, singular event and does not account for any potential cumulative exposure from other sources of contamination.

- Several physical parameters including but not limited to hydrodynamics, water depth, total suspended solids concentration, and wind speed were not sampled extensively throughout the entire modelled domain. However, the data that did exist was sufficient for this type of modelling. When data was lacking, professional judgment and previous experience was used to refine the model inputs.

- In the unlikely event of an actual release of oil, the trajectory, fate, and potential biological exposure will be strongly determined by the specific environmental conditions, the precise locations, and a myriad of details related to the event and specific timeframe of the release. Modelled results are a function of the scenarios simulated and the accuracy of the input data used. The goal of this study was not to forecast every detail that could potentially occur, but to describe a range of possible consequences and exposures of oil releases under various representative scenarios.

16.4.4.6 Summary of Modelling Results

For each of the modelled releases, oil on the surface was most likely to move to the east due to the prevailing westerly winds and surface currents within the region. Winds and currents in and around the Project Area are similar throughout the year, with most notable differences in wind intensity. The increased winds during wintertime conditions have the potential to enhance surface breaking waves and results in more complete entrainment of oil, which lowered the amount of oil that would remain on the surface for extended periods of time. In general, after 60 days, the majority of the oil was predicted to evaporate, entrain, and degrade, with very little oil remaining on the surface after 30 or 60 days, negligible sediment oiling, and extremely limited or non-existent shoreline oiling. Shoreline contact with oil was not predicted to be likely from any of the modelled releases. Of the 59 individual oil spill trajectory simulations for wintertime releases at the EL 1144 example well site, only three percent had shoreline oiling and only at Sable Island. There was no shoreline oiling predicted from summer scenarios for the EL 1144 example well site.

The releases modelled in this study may be considered representative of other potential releases in the Project Area. The depth of release of the EL 1144 and EL 1150 example well sites (1,137 and 378 m, respectively) are within the range of depths found throughout the Project Area.

The hypothetical releases modelled for this EIS are not intended to predict a specific future event, but rather to be used as a tool in environmental assessment and release contingency planning. The results presented (see Appendix G) demonstrate that there are a range of potential trajectories and fates that could result if a release of crude oil or a batch spill of marine diesel were to occur, and those trajectories and fates vary based upon the environmental conditions occurring at the time. While each oil release is unique and therefore uncertainties exist, the results of this modelling study suggest that if oil were to be released in the Project Area, it has the highest likelihood of moving away from shore to the east.

16.5 Fate and Behaviour of Potential Drill Fluid (SBM) Spills

In order to assess the fate and behavior of potential SBM spill scenarios, Amec Foster Wheeler (2017, see Appendix H) conducted trajectory and fate modelling in support of this EIS.

A numerical SBM droplet dispersion model, developed by Amec Foster Wheeler, employs a transport computation to simulate the advection of dispersed SBM droplets in three dimensions through the water column, following accidental release into the sea, until the particles come to rest on the sea bottom. Key inputs for the model include SBM droplet characterizations and ocean currents. The primary outputs are predictions of the probable area and locations of the SBM footprints on the seabed for each seasonal scenario (e.g., footprint length, area, thickness and distance from the drilling site).

Two plausible worst-case accidental SBM release modes were identified and considered in the modelling study:

- Inadvertent surface release of the entire volume (64 m^3) of the active fluid system over a period of 1-2 hours; and

- Subsurface SBM release from the marine riser and associated transport lines, during an emergency BOP disconnect event (255 m^3 at EL 1144, 89 m^3 at EL 1150), over a period of about two hours.

The seafloor footprints resulting from the modelled accidental SBM spills at EL 1144 example well site are summarized in Tables 16.12 and 16.13 for the intermediate and production drilling phases, respectively. The results include the distance of the spill footprint centers from the drilling site, whereby the footprint centers represent the location with the maximum spill thickness per unit area.

The SBM footprint statistics for the intermediate drilling phase at the deep site indicate that most SBM spills at the surface would reach the seafloor within a maximum of one km from the drilling site, with the median spill distance ranging from 184 m (in summer) to 743 m (in fall) from the drilling site. The variability of footprint locations among seasons is due to differences in the magnitude and direction of the mean seasonal currents. However, the median and maximum footprint sizes are comparable among seasons, due to the relatively small variability of currents within the brief SBM release periods, with footprint length (along the longer axis) median values of up to 124 m (spring), and maximum values of up to 220 m (summer) for the surface release scenarios. Total SBM footprints for the surface spill scenarios are predicted to have median areas of about 4,500 m2 and maximum areas of 9,000 m2, resulting in initial SBM spill deposits with average thicknesses of 1.7 cm, and maximum thicknesses of 7.1 cm.

The surface spill statistics are similar for the two SBM density values considered at EL 1144 example well site, although the slightly denser SBM used during the production drilling phase is expected to be transported to slightly shorter distances (median values of 136 m in summer, and 554 m in fall) from the drilling site than the lighter, intermediate phase SBM. The footprint lengths and areas for the production phase are also correspondingly smaller than in the intermediate phase, with median lengths of up to 98 m (spring and fall), and maximum lengths of about 168 m (summer). Footprint areas for the production phase surface releases are smaller than those for the intermediate phase, with median values of 3,600 m2 and maximum values of 7,200 m2 for all seasons. While the maximum modelled

thicknesses of 7.1 cm are the same as in the intermediate phase scenarios across seasons, the average thickness is slightly higher at about 2.2 cm.

The results of the surface spill of EL 1144 example well illustrate that for both drilling phases the spills are expected to result in deposits up to several hundred meters to the west-southeast of EL 1144, depending on the prevailing ambient current conditions for each season. The modelling results indicate notably narrower spatial distributions of the possible footprint center locations for the denser SBM in the production phase compared to the intermediate phase, consistent with the higher terminal fall velocities and lower travel times.

The SBM originating from a potential BOP disconnect scenario at EL 1144 example well site for both drilling phases is expected to contact the seafloor much closer to the drilling site (within about 40-60 m in all seasons), resulting in smaller initial footprint areas, but potentially larger initial SBM layer thicknesses in the range of 23-28 cm. The relatively small vertical distance to the seafloor, and the low ambient near-bottom currents result in low SBM dispersion rates and similar outcomes for all seasons and SBM densities. The final size and thickness distribution of the SBM footprints in these cases is expected to vary based on the features of the local seafloor.

The seafloor footprints resulting from the modelled accidental SBM spills at EL 1150 example well site are summarized in Table 16.14. The modelled spill distances from the drilling site are generally shorter compared to the deepwater site, with median footprint center distances ranging from 106 m (summer) to 201 m (winter), and maximum distances ranging from 322 m (summer) to 424 m (winter).

Footprint length scales at the EL 1150 example well site are slightly shorter than at the deepwater site, with median values ranging from 81-84 m across seasons, however the maximum lengths are slightly higher than at the deepwater site, ranging from 237 m (fall) to 250 m (summer). These findings can be attributed to a slightly larger range of current variability at the shallow water site (EL 1150 example well site) compared to the deepwater site at EL 1144 example well site, resulting in a wider range of individual spill sizes within each seasonal scenario. This is also reflected in the modelled footprint areas, with median values of 2,700 m2, and maximum values of 9,900 m2. Due to the lower median footprint sizes, the average SBM deposit thickness is higher at about 2.6-2.7 cm, but the maximum thickness of 7.1 cm is comparable to the deepwater site.

The seasonal probability maps of spill center locations indicate that SBM spill deposits are most likely to reach the seafloor within the quadrant northeast of EL 1150 consistent with the prevailing seasonal mean currents at this location.

Table 16.12 EL 1144 Deepwater Jurassic Example Well Location, Seasonal SBM Footprint Statistics, Intermediate Phase

SBM DISPERSION		Distance from Site (m)		Footprint LENGTH (m)		Footprint AREA (m2)		Layer Thickness (cm)	
		max	median	max	median	max	median	max	avg
Surface	winter	620	422	165	95	7200	3600	7.1	2.2
	spring	441	273	157	98	7200	3600	7.1	2.1
	summer	264	136	168	93	7200	3600	7.1	2.2
	fall	726	554	161	98	7200	3600	7.1	2.2
BOP	winter	57	57	32	31	3600	900	28.3	25.1
	spring	57	57	32	31	3600	900	28.3	23.7
	summer	57	41	33	31	3600	900	28.3	23.6
	fall	57	57	32	31	1800	900	28.3	27.2

Table 16.13 EL 1144 Deepwater Jurassic Example Well Location, Seasonal SBM Footprint Statistics, Production Phase

SBM DISPERSION		Distance from Site (m)		Footprint LENGTH (m)		Footprint AREA (m2)		Layer Thickness (cm)	
		max	median	max	median	max	median	max	avg
Surface	winter	838	573	215	119	9000	4500	7.1	1.7
	spring	589	370	205	124	9000	4500	7.1	1.7
	summer	364	184	220	117	9000	4500	7.1	1.7
	fall	982	743	210	123	9000	4500	7.1	1.7
BOP	winter	57	57	33	32	3600	900	28.3	25.1
	spring	57	57	33	32	3600	900	28.3	23.7
	summer	57	41	33	32	3600	900	28.3	23.6
	fall	57	57	33	32	1800	900	28.3	27.2

Table 16.14 EL 1150 Shallow Water Cretaceous Example Well Location, Seasonal SBM Footprint Statistics

SBM DISPERSION		Distance from Site (m)		Footprint LENGTH (m)		Footprint AREA (m2)		Layer Thickness (cm)	
		max	median	max	median	max	median	max	avg
Surface	winter	424	201	246	82	9900	2700	7.1	2.6
	spring	388	170	247	84	9900	2700	7.1	2.6
	summer	322	106	250	81	9000	2700	7.1	2.7
	fall	338	146	237	83	9900	2700	7.1	2.6
BOP	winter	41	14	39	33	2700	900	9.9	8.2
	spring	57	41	39	33	2700	900	9.9	7.7
	summer	57	41	39	33	2700	900	9.9	7.9
	fall	57	41	38	33	2700	900	9.9	7.7

16.6 Environmental Effects Assessment

The sections that follow assess and evaluate the potential environmental effects that may occur in the unlikely event that an accident such as a marine diesel spill or blowout occurs at some point over the course of the Project.

The assessment is based largely on the various spill modelling exercises conducted for this Project, as summarized earlier in Sections 16.4 (oil spill modelling) and 16.5 (SBM spill modelling), and described in further detail in Appendices G and H. As discussed, the modelling has been completed based on a credible worst-case, unmitigated approach for each spill scenario, where no preventative or spill response measures were considered. The environmental effects assessment for each VC considers each of the following potential and modelled accidental event scenarios, and considers the various spill prevention and response procedures and requirements described in Section 16.1:

- Marine Diesel Spills Scenarios
  - 100 litre batch spill at EL 1144
  - 1,000 litre batch spill at EL 1144
  - 750,000 litre at hypothetical vessel collision location
- Drilling Fluid (SBM) Spill Scenarios
  - 64 m^3 surface spill at ELs 1144 and 1150
  - 255 m^3 subsurface spill at EL 1144
  - 89 m^3 subsurface spill at EL 1150
- Uncontrolled Well Event
  - Blowout at EL 1144 example wellsite
  - Blowout at EL 1150 example wellsite

The relevant VCs identified and assessed for the effects assessment for planned Project components were carried forward for the accidental events environmental effects assessment, namely the following:

- Marine Fish and Fish Habitat;
- Marine and Migratory Birds;
- Marine Mammals and Sea Turtles;
- Special Areas;
- Indigenous Peoples; and
- Fisheries and Other Ocean Uses.

It should be reiterated that the accidental even scenarios are modelled as an unmitigated spill and do not take into account the Nexen procedures aimed to prevent and/or respond to such an incident (Section 16.1).or the overall potential of such an event occurring, based on the spill probability statistics and analysis (Section 16.3). The accidental event assessment, however does consider these two components. Although the atmospheric environment has been assessed in the environmental effects assessment for planned Project activities (Chapter 14), and it is recognized that there are possible air quality implications that would result from the presence of hydrocarbons in the marine environment during a spill event, air quality has not been included as a VC in the assessment for accidental events.

Several previous studies have evaluated the effects of large oil spills on air quality, and have shown relatively limited effects based on actual blowout events. Studies during the Deepwater Horizon (DWH)

spill in the Gulf of Mexico, for example, assessed the resulting air quality in terms of aromatics, particulate matter, ozone concentration, and gaseous hydrocarbons and compared them to the air quality in major urban areas (Ravishankara and Goldman 2011). They found that most of the resulting air pollution was trapped to the lower layer of the atmosphere (Marine Boundary Layer, 1st 600 m). The aromatic concentrations (benzene, toluene, etc.) near the spill were higher than urban areas but particulate matter and ozone concentrations were comparable to urban areas. Measured gas-phase hydrocarbons were found to be emitted from a relatively small area near the DWH spill site. The actual aromatic, particulate, or other atmospheric emissions would be highly variable and influenced by the weather and oceanographic conditions and hydrocarbon properties

The environmental effects assessment that follows is focussed on those aspects of the environment which are considered to be of primary concern with regard to such an unplanned event in the marine environment and its possible environmental consequences, namely, the various VCs listed above. Notwithstanding the potential, temporary, implications of such a spill event for air quality in the area, the rapid evaporation of spilled hydrocarbon materials into the atmospheric environment is considered preferable as opposed to its extended presence in the marine environment, and resulting effects on the VCs noted above. The oil spill modelling completed for this EIS (Appendix G) provides an analysis of anticipated evaporation rates for the various spill events modelled.

Further analysis and consideration of the possible atmospheric emissions associated with a large spill event may, for example, be undertaken as part of the analysis of possible spill response options, such as in situ burning, where the potential environmental effects and benefits of these various response options will be evaluated by Nexen and appropriate regulatory authorities

16.6.1 Key Modelling Results Integrated into the Assessment

For some of the hydrocarbon spill scenarios (marine diesel spills and subsurface crude oil blowouts), the assessment considers a number of established ecological and socioeconomic thresholds related to surface oil thickness, mass of shoreline oiling, and concentration of contaminants in the water column in assessing the potential for adverse effects to occur, as summarized in Table 16.15 below. This information is further detailed in Section 16.4.

Table 16.15 Ecological and Socioeconomic Thresholds for Oil Related Environmental Effects

Oil Type/Component	Ecological Threshold	Socioeconomic Threshold
Surface Oil	10 µm thickness (equivalent to 10 g/m^2)	0.04 µm thickness (equivalent to 0.04 g/m^2)
Shoreline Oil	100 g/m^2	1 g/m^2
Water Column Oil	1 ppb (1 µg/L) dissolved PAH or 100 ppb whole oil (100 g/L THC)	

The relevant modelling results are summarised here in the overall context of their ecological and socioeconomic relevance and the specific component of the ocean that is potentially affected (surface, water column, coastal, seafloor). It should be reiterated that the accidental even scenarios are modelled as an unmitigated spill and do not take into account the Nexen procedures aimed at preventing and/or responding to such an incident (Section 16.1). In addition, the overall potential for any such event to take place is discussed in the spill probability statistics and analysis section of this EIS (Section 16.3). The accidental event assessment, however does consider these components.

16.6.1.1 Marine Diesel Spills Scenarios (Batch Spills and Vessel Collision Scenarios)

Modelling of batch spills (100 L and 1,000 L) at the EL 1144 example well site) suggest a patchy and discontinuous colorless and silver sheens of less than 0.0001 mm (0.1 µm) thickness predicted over limited distances. With regard to the potential for surface effects, the thicknesses above the ecological threshold (10 µm thickness) would be less than one km^2 for both batch spill events. With regard to the areas that are predicted to exceed socioeconomic thresholds (0.04 µm surface thickness) the area exceeding this level would be less than one km^2 was predicted for the 100 L release scenario and eight km^2 for the 1,000 L scenario. In the water column, the ecological thresholds were not predicted to be exceeded, due to the combination of small volume releases and grid resolutions used to determine concentrations. The threshold for potential water column effects (100 µg/L THC) was only predicted for the subsurface volumes of water for less than one km^3 subsurface volume for both scenarios. Contaminant concentrations would be predicted to be highest in the immediate vicinity of the release location but would be predicted to remain offshore, dissipating rapidly (ultimately to less than 0.01 percent of the released volume remaining on surface after 30 days) due to evaporation, dissolution/dispersion, and degradation. For the 100 L and 1,000 L release the model predicted no shoreline interaction and less than 0.01 percent of the total mass of the released oil reaching the seafloor after 30 days.

The hypothetical vessel collision with 750,000 L related spill event was predicted to result in more extensive contamination (including surface and subsurface oil), when compared to the modelled “batch spills.” The release was predicted to result in patchy and discontinuous surface sheens that would likely result in a rainbow sheen over approximately 40 km of sea surface before transitioning to the colorless and silver sheen that was predicted for the batch spills. The larger release volume was predicted to result in larger exposure areas for surface oil including 13 km^2 for the 10-µm ecological threshold and 925 km^2 for the socioeconomic threshold (0.04 µm). The threshold for water column concentration (100 µg/L THC) was predicted to be reached for a subsurface volume totaling 100 km^3. These concentrations would be highest in the immediate vicinity of the release location but are predicted to dissipate rapidly (ultimately less than 0.01 percent of the released volume remaining on surface after 30 days) with distance. For the 750,000 L release the model predicted no shoreline interaction and 0.01 percent of the total mass of the released oil reaching the seafloor after 30 days.

16.6.1.2 Drill Fluid (SBM) Spill Scenarios

The modelling completed for a potential accidental release of SBM during Project-related drilling indicates that a surface SBM spill would reach the seafloor within a maximum of one kilometre from the drill site for the deeper EL 1144 site and less than 0.5 km at EL 1150 (the shallower site). The average thickness of the SBMs on the seafloor for EL 1144 exploration well site subsurface spill are predicted to be 1.7 cm with a maximum thickness of 7.1 cm. For a subsurface spill at EL 1150 example well site, the SBMs would reach the seafloor faster with a smaller (within about 40-60 m from source in all seasons) but thicker seafloor footprint (average 2.6-2.7 cm) when compared to a surface spill.

16.6.1.3 Uncontrolled Well Event

The subsurface blowout scenario for the EL 1144 example well site was a 30-day unmitigated flow of 184,000 bbl/day for 60 days modelling duration at 1,137 m depth (see section 16.4 and Appendix G for detailed modelling results). Results indicate that the areas most likely (i.e., over 90 percent; based on

stochastic results) to reach or exceed the ecological threshold for in-water concentration (1 µg/L PAH or 100 µg/L THC) includes areas to the east and south of the release site that extend 800 – 1,200 km. The stochastic model predicted a less than three percent probability of shoreline contact at Sable Island after 52-53 days of an unmitigated release. The oil that was predicted to contact the shoreline would be <0.01 percent of original spill (99th percentile) and would be highly weathered. The 52-53 day timeline would provide time to implement shoreline response measures to reduce the quantity of oil reaching the coastal areas. The model also predicts that the oil surface concentrations at the shoreline exceeding the ecological threshold of 100g/m^2 would occur across less than one km^2. The socioeconomic threshold (1 g/m^2) would be exceeded at 13 km^2. The model predicted 0.01 percent of the total release reaching the seafloor after 60-day simulation.

The subsurface blowout scenario for the EL 1150 example well site was a 30-day unmitigated flow of 44,291 bbl/day release modelled for 60 days at 378 m depth (see Section 16.4 and Appendix G for detailed modelling results). Results indicate that the areas most likely (i.e., over 90 percent; based on stochastic results) to reach or exceed the ecological threshold for water column concentration (1 µg/L PAH or 100 µg/L THC) includes areas to the east and south of the release site that extend 400 – 800 km. For surface oil concentrations, the ecological threshold (10 µm thickness) is reached at approximately 200-400 km to the east and south of the release site. Releases at the EL 1150 example well site were not predicted to make contact with shorelines. The model predicted 0.02 percent of the total release reaching the seafloor after 30 days.

16.6.1.4 VC-Specific Context

The environmental effects assessment for each VC considers the potential spill events (as modelled) in the context of the characteristics of the particular VC in question and its known spatial and temporal distributions (see Chapters 6-7). As the trajectory modelling report (Section 16.4, Appendix G) covered two modelling interpretations (stochastic and deterministic) with 38 separate illustrative maps, some deductions had to be made in the assessment analysis to obtain meaningful comparisons of the most relevant modelling results related to the subsurface blowout scenarios with the corresponding VCs.

For example, for the Marine Fish and Fish Habitat VC, a key focus of the assessment was predicted oil concentrations in the water column. A conservative approach to assess the effects on fish and fish habitat was to take the 95th percentile to represent credible worst case scenarios for total hydrocarbon concentrations in the water column. For marine and migratory birds, oil concentrations at the sea surface and possible shoreline exposure were more relevant. Table 16.16 lists the various VCs under consideration and identifies the most relevant model results in context of the environmental effects assessment.

It should be reiterated that while the environmental effects assessment is informed by the modelling of potential unmitigated spill events, it also considers the overall potential of such an event occurring, based on the spill probability statistics and analysis presented earlier (Section 16.3), and the various regulatory processes and Nexen procedures aimed to prevent and/or respond to such an incident (Section 16.1). The modelling results, however, do not consider these prevention and response measures.

Table 16.16 VCs and Corresponding Relevant Modelling Results for Subsurface Blowouts

	Component[1]				
VC	**Sea Surface**	**Water Column**	**Shoreline**	**Relevant Deterministic Model Results**	**Corresponding Simulations**
Marine Fish and Fish Habitat	L	**H**	L	95th Percentile Water Concentration[2]	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
Marine and Migratory Birds	**H**	M	**H**	95th Percentile Oil Thickness	June 13, 2006 (EL 1144)/April 20, 2007 (EL 1150)
				99th Percentile Shoreline Exposure[2]	October 2, 2008 (EL 1144)[3]
				95th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
Marine Mammals and Turtles	**H**	**H**	M	95th Percentile Oil Thickness	June 13, 2006 (EL 1144)/April 20, 2007 (EL 1150)
				95th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
Special Areas	**L**	**H**	**H**	95th Percentile Water Concentration[2]	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
				99th Percentile Shoreline Exposure	October 2, 2008 (EL 1144)[3]
Indigenous Peoples	**H**	**H**	**H**	95th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
				99th Percentile Shoreline Exposure	October 2, 2008 (EL 1144)[3]
				95th Percentile Oil Thickness[2]	June 13, 2006 (EL 1144)/April 20, 2007 (EL 1150)
Fisheries and Other Ocean Uses	**H**	**H**	L	95th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
				95th Percentile Water Concentration[2]	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)

[1]High(H), Medium(M), and Low (L) chance of interaction of the VC with the component
[2]To give further spatial context relating the oil spill scenarios and the corresponding VCs, these deterministic modelling results were overlaid on the relevant VC information in the following sections
[3]Only EL 1144 example well site had a model prediction that reached the shoreline

It also considers the planned application of mitigation measures to respond to any such spill event in the unlikely event that it did occur, and their implications for preventing or reducing spill volumes and the geographic extent and duration of a spill event (Section 16.1). The assessment concludes with a determination of the significance of such effects, based on the same VC-specific definitions used for planned Project components and activities.

In the unlikely event of an accidental event such as a spill or a blowout, specific environmental monitoring programs may be required, which will be developed and implemented in consultation with the appropriate regulatory agencies.

16.6.2 Marine Fish and Fish Habitat (including Species at Risk)

Marine fish and fish habitat components relevant to the Project Area and larger RSA include plankton, benthos and finfish. The presence, abundance and distribution of particular species varies considerably based on habitat characteristics (both abiotic and biotic) and variability across this large and diverse marine environment, which includes parts of the Newfoundland Shelf, Flemish Cap and adjacent slope and deepwater habitats in the Flemish Pass. Within these areas and associated habitat types, a variety of fish species and assemblages occur with such factors as water depths and habitat complexity being key determining factors of species presence and prevalence.

The Project Area and RSA also host a number of commercially relevant fish and shellfish species which are important for both Canadian and/or international fishers. Deep-sea corals, seapens, and sponges are often of particular environmental interest due to the habitat-forming capacity of these benthic invertebrates, their importance in supporting early life stages of fish and invertebrates, and their relative sensitivity to anthropogenic stressors. Existing and available information for corals, seamounts, and sponges in this region indicates that portions of the Project Area and RSA overlap with several areas of known occurrence for these species. Secure and at risk fish and invertebrate species of commercial, cultural and/or ecological value are known to occur in the area and could therefore be affected by an accidental event.

The potential effects of the accidental release of hydrocarbons in the marine environment on marine fish and fish habitat are largely dependent on a variety of biotic (species, life history, behaviour, resistance) and abiotic (oceanographic conditions, exposure duration, oil type, oil treatment methods) factors. The extent of the potential effects depends on how the spill trajectory and the various components of the VC overlap in both space and time.

16.6.2.1 Potential Issues and Interactions

The potential environmental effects included in the assessment of planned Project components and activities (Chapter 8) included:

- Change in habitat availability and quality
- Change in food availability and quality
- Change in fish mortality, injury, health
- Change in fish presence and abundance (behavioral effects)

These potential effects remain relevant to the assessment of accidental events, although the mechanisms or pathways of effects may be different. The extent of any potential effects on marine fish and fish habitat may depend largely on the level and timing of exposure to any toxic components of the oil. Potential accidental effects considered involve varying degrees of hydrocarbon exposure including batch spills and subsurface blowouts. Given the known injury and behavioural responses of marine species to hydrocarbon interactions (as described below), batch spills and subsurface blowouts were

assessed through the Project specific modelling that considers various scenarios of hydrocarbon release.

Existing Knowledge of the Effects of Hydrocarbons on Marine Fish and Fish Habitat

A review of the potential effects of oil and dispersants is presented below for plankton, fish, invertebrates and sensitive coral and sponge species. Information on the potential effects of hydrocarbons on fish and fish habitat are derived primarily from laboratory studies and known responses of North Atlantic species to anthropogenic disturbances. Recent in situ studies of large-scale hydrocarbon spill events are based largely on the DWH that describe the fate and effects of oil, and oil dispersants on the environment. While the studies are based on an event in a relatively warm environment, they are relevant to an overall understanding of the potential effects on fish and fish habitat in more temperate environments, including the Project Area and RSA. A review of the potential environmental effects on Arctic marine environments also provides useful information for temperate areas (Peterson et al 2003; Olsen et al 2011; AORST-JIP 2014; Bejarano et al 2017).

Plankton and Microbes

Plankton are a key component of primary and secondary production in ocean environments, and potential effects on these organisms may have implications for higher trophic levels. The response of plankton and other microbial communities to oil spills is diverse and largely dependent on exposure level. In general, plankton and other microorganisms do not have an avoidance response to contaminants, as oceanographic conditions largely control their horizontal movements. However, certain coastal and estuarine zooplankton have been shown to be able to detect and avoid small patches (1-7 cm) of hydrocarbon- contaminated water (Seuront 2010), resulting in distribution changes.

Oil exposure of phytoplankton to oil may result in altered productivity and growth, with possible population-level effects on abundance and community composition (Buskey et al 2016). Depending on the species involved, crude oil concentrations up to 1 mg/L may have stimulant effects on phytoplankton growth, whereas concentrations over 1 mg/L may cause growth inhibition, and concentrations over 100 mg/L result in severe or complete growth inhibition (Rabalais 2014). This may shift community composition, depending on species presence and relative tolerances (Ozhan et al 2014). For example, five-day crude oil exposures to 8.6-23 mg/L resulted in decreased oceanic phytoplankton and large diatoms and stimulant effects on small diatoms (González et al 2009 in Ozhan et al 2014). Laboratory studies on Arctic phytoplankton resulted in growth inhibitions for two diatom species found in and around sea ice (Van Baalen and O'Donnell 1984) at crude oil concentrations over 50 mg/L and green flagellates have showed increased growth for an exposure regime of 10 mg/L (Hsiao et al 1978). Some arctic field studies on diatoms from ice algal communities found no decreases in cell densities, chlorophyll a concentrations or productivity when exposed to a field release of dispersed weathered oil (Cross 1987). Changes in both plankton population (biomass) and community assemblages on the Louisiana Shelf after the DWH spill where there with a shift from ciliates and phytoflagellates to diatoms and cyanobacteria (Parsons et al 2015). Remote sensing of chlorophyll a after the DWH spill indicated a strong but short-lived stimulation in regional phytoplankton, however the reduction in photosynthetic capacity in near-surface waters from the spill likely had negative population effects on phytoplankton (Ozhan et al 2014).

Laboratory oil exposure studies have shown lethal and sublethal effects on zooplankton (Sueront 2010; Almeda et al 2013; AOSRT-JIP 2014; Busky et al 2016) but with few documented mass mortality events related to oil slick episodes (Seuront 2010). Zooplankton may take up oil components passively, through ingestion of hydrocarbon exposed phytoplankton, or direct ingestion of crude oil droplets (Almeda et al 2014, 2016). Lethal concentrations of dispersed oil from the DWH spill are estimated to be approximately 27 ppm (Almeda et al 2014, 2016). Sublethal effects range from physiological, feeding fecundity, and behavioral responses related to predator avoidance (Almeda et al 2013). Various studies have observed reduced reproductive success in copepods exposed to a range of hydrocarbon concentrations including reductions in egg production and reductions or delays in hatching. Comparison of fresh crude oil and weathered indicated that weathered was generally considered less toxic to zooplankton due to the loss of volatile fractions (Almeda et al 2013). Laboratory exposure studies comparing arctic and temperate-boreal copepod species have found that Arctic species are less sensitive to oil exposure (Hansen et al 2011; Gardiner et al 2013) but this may be related to a delayed response time for the Arctic species (Hansen et al 2011).

Seasonal plankton blooms generally coincide with increased presence of ichthyoplankton (fish eggs and larvae) that capitalize on increased food levels in the water column. Exposure to oil has potentially lethal and sublethal effects on these sensitive early life history stages (Lee et al 2015; Sørensen et al 2017; O'Shaughnessy et al 2018). Similar to zooplankton, ichthyoplankton likely have limited avoidance abilities. Laboratory experiments with Atlantic herring larvae exposed to total PAH levels of 0.129-6.019 µg/L for 12 days resulted in higher mortalities compared to control groups (Ingvarsdóttir et al 2012). Although there were no further differences in mortalities compared to control groups during a two month recovery period, increased deformities and reduced growth were observed in exposed larvae (Ingvarsdóttir et al 2012). Similarly, exposure of embryos of Atlantic cod and Atlantic haddock to dispersed crude oil (10-600 µg/L) resulted in heart and craniofacial deformities (Sørensen et al 2017). Exposures of bay anchovy to varying levels of weathered oil indicated that more weathered oil had a higher toxic effect at the embryonic and hatching stages (O'Shaughnessy et al 2018). Ichthyoplankton responses can be species specific as demonstrated by ichthyoplankton surveys before and after the DWH spill where there were no changes in body condition of Spanish mackerel was documented, but relatively poorer body condition of red snapper was recorded (Hernandez et al 2016; Ransom et al 2016). While changes in body condition were noted, ichthyoplankton abundances of both species did not change between pre- and post-DWH spill surveys (Hernandez et al 2016; Ransom et al 2016). Experimental exposure of larval echinoderm and bivalve invertebrate species to oil from the DWH spill indicated that weathered oil had no effect on survival and development, however fresh oil resulted in adverse effects (Stefansson et al 2016). While potential effects on larval stages have been identified, overall reductions may not necessarily have population-level negative effects on adult populations (Gallaway et al 2017; Carroll et al 2018).

Microbes and plankton serve an important role in moving surface oil from the waters into the deep ocean through formation of marine snow. Marine snow is a continuous shower of mostly organic detritus that has been degraded by microbes, clumps together, and settles from the upper layers of the water column. A similar pathway has been seen after oil spills in which microbes degrade hydrocarbons into marine snow helping to shunt degraded hydrocarbons through the water column (Passow et al 2012; Daly et al 2016). Flocculated hydrocarbon material may also be ingested by zooplankton as it settles, expelled through fecal pellets which further enhances settling of hydrocarbon material to benthic environments (AOSRT-JIP 2014; Almeda et al 2016). This natural mechanism is an important link between benthic and pelagic environments that brings important nutrients and organic matter from

surface waters to the deep sea, however, during spill events, may serve to contaminate deep sea corals and benthic communities through this pathway (Rabalais 2014). Based on laboratory and field studies, similar mechanisms of microbial degradation of oil have been shown in the Arctic (Prince et al 2013), though at slower rates than in more temperate environments (AOSRT-JIP 2014). Gelatinous zooplankton such as jellyfish, may also help move oil from surface waters to the water column through increased production and shedding of mucous when exposed to the physiological stress of oil exposure (Gemmell et al 2016). However, oil degrading bacterial were also shown to be able to grow faster in the contaminated mucous and increase rates of oil degradation (Gemmell et al 2016) which may reduce hydrocarbon transport to benthic areas.

Depending on the persistence of hydrocarbons in the environment, influences on the planktonic phase of fish and invertebrate species may limit distributions, recovery, and recolonization. The potentially longer term lethal and sublethal effects on plankton and microbes may reduce overall food resources and affect higher trophic levels such as pelagic fish and benthic organisms. Many fish and invertebrate species also have one or more life stages in a planktonic phase, hence affecting recruitment to adult fish and invertebrate populations.

Invertebrates and Fish

The primary hydrocarbon spill exposure mechanism to marine biota is through the dissolved portion in the water column as the most acutely toxic compounds are both volatile and water soluble (i.e., PAHs) (French-McCay 2009). Exposure studies using the dissolved fraction of oil have found lethal and sublethal values for fish in the range of 0.3 to 60 µg/L dissolved PAHs (0.03-11 mg/L TPH) (Lee et al 2015). Cold water fish species have been shown to have comparable ranges with lethal values for fish of 0.7 – 4.0 mg/L TPH (AOSRT-JIP 2014). These ranges coincide with the ecological threshold of 1.0 µg/L dissolved PAHs (corresponding to approximately 100 µg/L of whole oil or THC), that was used as a modelling reference in this study and serves as a threshold to predict the hydrocarbon exposure effects on marine species. Laboratory exposure studies, in general, have shown more severe effects than measurements taken in situ during and after actual spills. It is generally agreed upon that development stages of fish and invertebrates are more sensitive to oil than adult stages (Ingvarsdóttir et al 2012; Lee et al 2015; Sørensen et al 2017; O'Shaughnessy et al 2018), however effects on larval stages does not necessarily result in effects on adult populations (Gallaway et al 2017; Carroll et al 2018).

Acute toxicity (short-term exposures) would be more representative of exposure during a discrete batch spill event. The ecological risks for this type of exposure would be reduced as the more toxic components of the spill, lower molecular weight compounds (LMW), evaporate and dilute rapidly (Lee et al 2015). There are however, documented sublethal effects such as reduced feeding (Lari et al 2015) and larval deformities (Mager et al 2014). Potentially lethal effects (associated with LMW) include a variety of responses related to lipid membrane receptors in effects collectively termed narcosis (Peterson et al 2003). Continued exposure can results in symptoms that range from depression in respiratory-cardiovascular activity, tissue hypoxia and ultimately respiratory paralysis (death) if exposure continues. These effects are short term as the LMW volatize from the oil on the order of days (Lee et al 2015). Cold water invertebrate taxa (bivalves, gastropods, crustaceans) have been shown to have comparable reactions in terms of specific PAH sensitivities when compared to temperate species (Olsen et al 2011). These short-term effects can be recoverable if exposure does not continue.

Chronic, long-term exposure would have a range of potential effects from genetic and molecular responses of cells to effects on reproduction, growth, disease, and survival (Lee et al 2015; Busky et al 2016). The uptake pathways vary but can include respiratory uptake, direct contact, diet, or maternal transfer to eggs (Lee et al 2015). Studies on finfish have shown that the dissolved oil components can travel across respiratory membranes in gills (Lee et al 2015). More recent studies have identified that the PAH phenanthrene disrupts cardiac function and is associated with heart malformations in developing fish and it becomes proportionally more toxic as the spilled oil weathers (Brette et al 2017). Long term exposure may also affect fish health and condition through susceptibility to higher parasite loads (Khan et al 1990). Uptake of PAHs in a bivalve indicated that it primarily accumulated in the gonads resulting in reproductive delays (Frouin et al 2007). Like invertebrates, deep-sea fish species typically have lower metabolisms, are slower growing, have longer life spans, and would likely be more susceptible to disturbances such as oil spills (Cordes et al 2016). As previously discussed, the early life stages are likely more sensitive to hydrocarbon exposures than adults (Lee et al 2015; Sørensen et al 2017).

Community and population-level effects from the DWH spill on regional fisheries were observed (Felder et al 2014; Murawksi et al 2016) that resulted in temporary effects on productivity (Murawski et al 2016). Recovery, however, was largely influenced by fisheries closures (Murawski et al 2016). These findings are in general agreement to population modelling studies on Arctic cod that predicted that even if large mortalities of Arctic cod juvenile and eggs were to occur due to a hypothetical spill event (as the early life stages are potentially the most susceptible to a spill), the effects on the regional cod population would be insignificant (Gallaway et al 2017; Carroll et al 2018). Species-specific population structure would be an important consideration as in the case of Arctic cod where diverse age distributions would help mitigate effects of single year recruitment reductions to the adult population (Carroll et al 2018). Studies from the DWH spill also showed strong declines in species richness and diversity in the decapod crustacean community post-spill (2010-2012) relative to earlier surveys (2004-2006) (Felder et al 2014). It has been theorized that hydrocarbon exposure may have caused localized mortalities, reduced the fecundity of surviving females or reduced recruitment (Felder et al 2014). The number of lesions observed on deep-water shrimp species surveyed after the spill increased nearly threefold (Felder et al 2014). Similar to fish, it is also important to highlight that deep-sea invertebrate species (less motile, lower metabolism, slower growing, long life spans) are likely to be more sensitive to anthropogenic disturbance (Cordes et al 2016). For example, severe reductions in benthic invertebrate abundance and community diversity was observed up to three km away from the Macondo well, with moderate effects up to 17 km away (Montagna et al 2013 in Busky et al 2016).

Unlike plankton and microorganisms, fish and invertebrates are generally motile and have higher capability to avoid oiled areas in the event of an accidental spill (Lee et al 2015). However, these reactions are species and life stage specific. As noted above, the embryonic life stages of both fish and invertebrates are more often less motile than their adult counterparts thereby more susceptible to spills. These effects on the early life stages are further compounded by their lower toxicity thresholds to spilled oils (Lee et al 2015). Laboratory exposure studies capelin (Frantzen et al, 2012) and larval sculpin (Gardiner et al 2013) have found similar results with increased embryo mortality rates and decreased hatching success. Deep-sea species of fish and invertebrates may be more susceptible to anthropogenic effects (Cordes et al 2016) as they would likely to have less successful avoidance strategy than their more pelagic counterparts.

Deep Sea Corals and Sponges

Corals and sponges have an important functional role and act as nurseries, refugia, spawning and breeding grounds for many aquatic species (Beazley et al 2013; DFO 2016). In deep sea ecosystems that are largely composed of flat and featureless soft-bottom areas, corals and sponges serve as ecosystem engineers creating complex three-dimensional features that are critical habitat to other taxa (Beazley et al 2013; Ragnarsson et al 2017). In general, their life histories (planktonic larvae, slow growing, long life spans, and slow recovery) and feeding mechanisms (suspension feeding) makes them susceptible to accidental events (Fisher et al 2014; Prouty et al 2016; Cordes et al 2016). Sessile adult and planktonic larvae of corals and sponges also have no known avoidance mechanisms to oil spill events.

The effects of hydrocarbons on corals are typically assessed in situ using visual indicators of stress (White et al 2012). Visual indicators of coral stress related to the DWH spill included partial tissue loss, excessive mucus production, retracted polyps, partial coverage by brown flocculant sourced to the spill and death (Busky et al 2016; Prouty et al 2016; Ragnarsson et al 2017). Follow-up studies on the DWH spill has shown a patchy distribution of effects which were highly site specific and included incidence of hydroid colonization, a sign of deterioration on affected coral branches (Hsing et al 2013). For example, one site 13 km to the southwest of the Macondo wellhead (lease block MC294) showed that over half of the corals were partially covered by a brown flocculant material but follow up surveys 16 months later indicated that recovery was occurring (Fisher et al 2014).

Sponges have been shown to have relatively high bioaccumulation capabilities for PAH compounds (Batista et al 2013, Gentric et al 2016). However, sponges exposed to hydrocarbons may exhibit highly variable accumulations as they may alter their filtering behaviours in response to contaminants (Kutti et al 2016). In short exposure experiments, altered feeding behaviours allowed sponges to cope with exposure to oil and dispersant contaminated sediments (Vad and Duran 2017). The PAH benzo(a)pyrene, a type of carcinogen, has been observed to be strongly bioaccumulated in sponges (Gentric et al 2016) with potential damage to sponge DNA (Zahn et al 1983). Presence of hydrocarbons may also have effects on larval distribution with experimental studies showing decreased larval settlement in the presence of hydrocarbons (500 and 100 ng/L PAH) and copper (Cebrian and Uriz 2007).

Existing Knowledge of the Effects of Dispersants on Marine Fish and Fish Habitat

Chemical dispersants do not remove oil from the environment but are utilized to disperse oil slicks from the sea surface into the water column, increasing hydrocarbon exposure to the microbes which should result in accelerated microbial degradation of spilled oil (Lee et al 2013; AOSRT-JIP 2014; Coelho et al 2017). Dispersant use after a spill has the potential to increase the exposure within the water column (i.e., plankton, pelagic fish) and eventually, the benthos (demersal fish, benthic invertebrates) (Ramachandran et al 2004). The dispersant serves to shear an oil slick into small droplets and mixing them in the water column making them more accessible to marine microbes that can metabolize and degrade the hydrocarbons (Gemmell et al 2016). Although it is generally agreed that dispersants increase the availability of oil to microbes in the water column by reducing oil droplets size, there still remains some debate on the effects on oil degradation rates (Brakstad et al 2014, 2015; Kleindienst et al 2015; Seidal et al 2016). For example, certain concentrations and ratios of oil to dispersant (15

percent oil: 1.5 percent dispersant) have been shown to reduce the effectiveness of certain degradation pathways related to the formation of microbial marine snow (Passow 2012; Seidel et al 2016).

Chemical dispersants are of toxicological concern due to the resulting interaction and effects of chemically dispersed oil on fish and fish habitat (DeLeo et al 2016). The main toxicological pathway is increased exposure to the more toxic components of oil (i.e., PAHs) to taxa occupying the water column (Pace et al 1995). Chemically dispersed oil has more pronounced effects on the early life stages of fish and invertebrates; specifically eggs and larvae (Cordes et al 2016, DeLeo et al 2016). For example, chemically dispersed oil is known to reduce larval settlement, cause abnormal development, and tissue degradation in sessile invertebrates (Cordes et al 2016). Similarly, laboratory studies on Atlantic herring eggs showed an increase rate of deformities and mortalities for dispersed oil exposure (1 mg/L total hydrocarbons; up to 14-day exposure) (Greer et al 2012). Plankton in particular may be sensitive to the combined toxicity of dispersants and crude oil. The dispersal of crude oil increases prevalence of small oil droplets compared to natural dispersal, that may be ingested by zooplankton (Almeda et al 2014). Dispersed oil was shown to be 2.3-3.4 times more toxic to copepods compared to crude oil alone with further increases in toxicity with exposure to sunlight (Almeda et al 2013). Experimental toxicity studies on rotifers indicated that oil and the chemical dispersant Corexit 9500a ® utilized during the DWH spill event were of similar toxicity, but the combined resulted in a 52-fold increase in toxicity (Rico-Martinez et al 2013).

Laboratory studies on deep sea coral from the Gulf of Mexico indicated that dispersed oil solutions were more toxic to the coral than untreated oil solutions (DeLeo et al 2016). These studies used three initial oil concentrations of 250 µM (high), 150 µm (medium), and 50 µM (low) with total initial dispersant concentrations of 176.7 mg/L (high), 106.0 mg/L (medium) and 35.3 mg/L (low). Like other invertebrates, the most dramatic effects related to early (larval) coral life stages with decreasing settling abilities and post-settlement survival (DeLeo et al 2016). In experiments with gorgonian corals, coral fragments were largely unaffected by weathered oil, but fragment mortality occurred within 48 hours of exposure to both chemical dispersants and combined oil and dispersants (Fromet et al 2017). While responses to dispersed oil are species-specific, there is evidence that relative sensitivity to dispersed oil is similar among arctic, temperate, and tropical species (Olsen et al 2011; Bejarano et al 2017).

Existing Knowledge of the Effects of Drill Fluids (SBMs) on Marine Fish and Fish Habitat

As described and discussed in Section 2.5.2.2, SBM-associated cuttings will be discharged in accordance with regulatory requirements as a component of drilling wastes for ongoing operations. Therefore the potential effects of SBMs in general are discussed in detail in Section 8.3.4 including SBM-associated drill cuttings. The effects considered here relate exclusively to an accidental discharge of SBM (i.e., drill fluid only).

Potential pathways of potential effects on fish and fish habitat would be the direct toxicity of the fluid and potential changes to fish habitat (degradation of benthic habitat, elevated TSS in the water column). SBMs were developed to replace oil-based muds (OBMs) that were historically used in drilling activities. The toxic components of the OBMs have been essentially removed in synthetic based fluids, resulting in drilling fluids that have lower acute toxicity (Tsvetnetko et al 2000; Hamoutene et al 2004; Paine et al 2014; Tait et al 2016). Potential base fluids for SBMs may include esters, poly alpha olefins, internal olefins, linear alpha olefins and others. Acute toxicity of SBMs is considered to be relatively low based on laboratory experiments and field evaluations of SBM-associated drill-cutting piles (Still et al 2000;

Tsvetnetko et al 2000; Hamoutene et al 2004; Paine et al 2014; Tait et al 2016). Lobsters injected with high levels of SBM, for example, did not change aspects of their lipid and protein metabolism or show any other adverse health effects after approximately 20 days (Hamoutene et al 2004). Toxicity experiments with fish indicated that acute toxicity of SBMs was generally low (96-h LC50 toxicity of over 30,000 mg/L, Jagwani et al 2011), but there were potential health effects with chronic exposure to SBM associated cuttings (Jagwani et al 2011; Gagnon and Baktyar 2013; Vincent-Akpu 2013). Any potential effects are likely to be temporary in nature as SBMs biodegrade within a few years (Terrens et al 1998; Ellis et al 2012; IOGP 2016).

Other potential effects include changes to fish habitat in terms of surface, water column, and the seafloor (benthos). A surface SBM spill would likely result in a surface sheen similar to what was described for batch spills but more limited in nature. SBMs, however, are a heavy, dense fluid which sinks rapidly so the effects on the water's surface would be limited as it sinks through the water column. Water column quality could be affected by increased SBM concentrations within the immediate area (increased TSS) but the area would be small and would generally become a source of organic matter which could be consumed by microbial processes before it reached the seafloor; this is largely dependent on the resident time of the SBMs within water column. If SBMs do reach the seafloor, there is the potential to create anoxic conditions through local eutrophication due to degradation of SBM organic components (Schaanning et al 2008; Ellis et al 2012).

16.6.2.2 Environmental Effects Assessment

The potential environmental effects of an accidental spill event on marine fish and fish habitat are assessed in the following subsections.

Marine Diesel Spills (Batch Spills and Vessel Collision Scenario)

The relevant model results for diesel spills (10 L, 1,000 L, 750, 000 L) are summarized in Section 16.4. The results from the models suggest that both the potential for exposure and the likelihood of adverse effects on fish and fish habitat from any such diesel releases are low. Fish in the immediate vicinity near the surface at the time of the spill may be exposed. At the concentrations predicted, change in habitat availability and quality will likewise be of low magnitude. While, batch spills would cause a decrease in water quality around the spill site, it would be short-term until the surface slick naturally disperses through surface wave action in the offshore environment. Fish within the immediate area near the surface may be able to avoid exposure until the slick is dispersed by surface wave action in the offshore environment). Fish unable to avoid the area may be affected by PAH exposure; however, change in fish health, mortality or injury is predicted to be of low magnitude because most of the oil would dissipate quickly; even the risk to those fish in the immediate vicinity unable to avoid the spill is considered relatively low. Plankton communities, including early life history stages of fish and invertebrates, would not be able to avoid exposure to a batch spill and therefore interactions with plankton communities in the immediate area may have lethal and sub-lethal effects.

It is therefore predicted that there would be localized and limited change in fish presence, abundance, and habitats for the duration and extent of the batch spill. Due to the short-term nature of small batch spills and overall quantity released, the presence of fish in the immediate area may decrease temporarily (mostly due to avoidance) but could return once the slick disperses (8,11, and 14 percent oil remaining entrained in water column after 30-day stimulation for 100 L, 1,000 L, and 750,000 L VCL

spill, respectively). It is possible that some zooplankton and ichthyoplankton would face mortality in the immediate footprint with the potential for a subsequent increase in phytoplankton (Ozhan et al 2014; Rabalais 2014; Busky et al 2016). Depending on the timing of the spill such as during seasonal spawning events, there may also be limited mortality and injury to planktonic early life stages of benthic organisms. However, these potential localized changes are not predicted to affect the overall population or abundance of the plankton community and therefore would have limited effects on higher trophic levels.

Modelling also predicts 0.01 percent or less of the hydrocarbons would reach the seafloor at the end of the 30-day simulations for all diesel spills, suggesting minimal effects on the benthic community, including corals and sponges. While there would be some flocculation of oil resulting in transport to benthic environments (Passow et al 2012; Daly et al 2016), the overall quantity and interaction with the benthos would be limited.

With spill prevention plans and response procedures in place, the potential environmental effects of a diesel spill (100, 1,000L, 750,000 L) on marine fish and fish habitat are predicted to be adverse but of low to medium magnitude, localized to within the RSA, short- to medium-term in duration, and reversible. This was determined with an overall moderate level of confidence.

Drill Fluid (SBM) Spill

The relevant drill fluid model results are summarized in Section 16.5. A SBM spill would have the potential to result in seabed disturbance, chemical toxicity, and bioaccumulation (uptake of contaminants by fish and the presence or perception of taint). As discussed in detail in Section 8.3.4, the acute toxicity of SBMs is considered relatively low and below environmental guidelines and therefore would not result in adverse effects from contamination of marine biota or habitats. Potential effects of a drill fluid spill on fish and fish habitat are predicted to be adverse, negligible to low in magnitude, short-term in duration, localized to within the Project Area, and reversible. This was determined with a high level of confidence.

Uncontrolled Well Event

The relevant model results for uncontrolled well events are summarized in Section 16.4. In the event of a blowout scenario, there could be potential effects within the water column, which could affect habitat availability and quality. Dissolved oil fractions in the water column constitute a physical and chemical change to the water column, especially for the first few meters (Appendix G). While the spilled oil itself is predicted to have minimal interaction with sediments based on the modelled scenarios (0.01-0.02 percent of spilled oil predicted to remain within sediment after 30 days), interactions with benthic fish habitat are likely due to flocculation and sinking events associated with plankton and microbial pathways (Passow et al 2012; Daly et al 2016).

Fish health and mortality may also be affected by an uncontrolled well event. Fish presence and abundance could also be affected with temporary avoidance of oiled areas. Local abundance may also be adversely affected depending on mortality levels resulting from interactions with hydrocarbons and dispersants. The effect on fish would depend on the timing of the event as some fish exhibit seasonal migrations or seasonally timed life stages. In particular, oil events during or soon after seasonal spring

and fall phytoplankton blooms are likely to interact with early life stages of various fish and invertebrates that coincide with these natural processes and are sensitive to hydrocarbon interactions.

Adult demersal and pelagic fish could potentially avoid the area, but juvenile and early life stages of fish and benthic invertebrates in the immediate areas would likely experience sublethal and lethal effects as described for a batch spill, but an uncontrolled well event would be over a greater area. Sublethal effects on juvenile and early life stages may also have species-specific implications (i.e. decreased reproductive success, deformities). Further potential effects on fish and fish habitat related to a large oil spill could amplify decreases in populations of fish that are already in decline. While an unmitigated spill event would have adverse effects on fish health and mortality, responses are largely species specific and there may, for example, be stimulant effects on particular species (Hernandez et al 2016; Ransom et al 2016). The overall effect could result in community composition changes during and after the spill.

Food availability and quality would be adversely affected in the case of an accidental spill event. Local reductions in plankton due to injury or mortality from hydrocarbon exposure (Ozhan et al 2014; Rabalais 2014; Busky et al 2016) may reduce foraging opportunities for fish especially if an accident were to occur during the spring and fall phytoplankton bloom. A chemically dispersed spill combined with photo-enhanced toxicity would result in relatively high mortality in plankton communities near surface waters (Almeda et al 2016). These potential adverse effects on plankton communities would potentially have food availability implications for higher trophic levels.

Fish habitats would be affected by an uncontrolled well event for the duration of the spill, depending on how oil is dispersed. As described above, fish would be displaced from the water column by crude oil presence. Furthermore, the combined effects of chemically dispersed crude oil and flocculation to create marine oil snow would potentially transport hydrocarbon components to benthic environments. In particular, sensitive coral and sponge species in benthic environments would likely be adversely affected which may have implications for other deep-sea species.

EL 1144 Example Well Site

For a potential subsurface blowout at the EL 1144 example wellsite, the nature and extent of potential effects on this VC will again depend on how the spill trajectory and fish and fish habitat overlap in both time and space. The extent of the modelled unmitigated spill (in-water oil concentration of THC) is illustrated in Figure 16.12 and includes the Flemish Pass and shelf and slope areas of the Flemish Cap and Newfoundland Shelf. These areas include productive and diverse fish habitats and areas of high abundance and biomass of various fish and invertebrate species. The deeper slopes along the Grand Banks and Flemish Cap that contains cold water and deepsea taxa less resilient to perturbations would also be affected. Negligible oil on the sediments was predicted by the model (0.01 percent), and therefore a large-scale direct effect on benthic fish habitat is not anticipated.

Such a spill would also affect fish health and mortality. Adult demersal and pelagic fish could potentially avoid spill areas, but the juvenile and the early life stages of fish and benthic invertebrates in the immediate areas of the spill would likely suffer from sublethal and lethal effects as described above. A spill of this magnitude would also have potential mortality, injury and sublethal effects on plankton that would have further implications on foraging opportunities and overall health of higher trophic levels.

Fish presence and abundance would also be affected by this unmitigated scenario as mobile fish species would temporarily avoid the spill footprint within the model results. The range of the predicted oil spill indicates potential displacements from highly productive areas including the southern Grand Banks and the Flemish Cap. There would likely be decreased presence and abundance of mobile fish and invertebrates for the duration of the spill, with subsequent recolonization.

The model predicts that any oil in contact with the shore would be below the ecological threshold (100 g/m^2). With the implementation of mitigation measures, including shoreline protection measures, it is unlikely that oil would reach the shoreline and therefore residual effects on coastal fish populations and coastal fish habitat are considered of low probability and minor overall.

As noted in Section 6.1.8, there are various fish species that are known to occur in the RSA which are designated as species at risk or species that are otherwise of conservation concern. In the unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of fish presence. Potential effects would be similar to those described above for secure species. The likelihood, however, of this type incident occurring with the relevant mitigations in place has been calculated to be extremely low (Section 16.3). In an actual event, emergency response measures would be implemented to limit the magnitude, duration, and extent of a spill. As indicated by the modelling, an unmitigated spill is unlikely to reach the shoreline and the implementation of emergency response measures will further reduce this likelihood.

With spill prevention plans and response procedures in place, the potential effects of a subsurface blowout at the EL 1144 site on marine fish and fish habitat are predicted to be adverse, medium in magnitude, medium to long-term in duration, occurring within the RSA, and reversible. This was determined with a moderate level of confidence.

EL 1150 Example Well Site

The potential effects of a possible subsurface blowout at the EL 1150 site will likewise depend on how the spill trajectory and fish and fish habitat overlap in both time and space. The modelled hypothetical releases at EL 1150 were not predicted to make contact with any shoreline.

The extent of the modelled unmitigated spill (in-water oil concentration of THC) is illustrated in Figure 16.15 and includes the Flemish Cap. These areas include productive and diverse fish habitat in the RSA and areas of high abundance and biomass of various fish and invertebrate species. As noted in Section 6.1.8, there are various fish species that are known to occur in the in the LSA and/or RSA which are designated as species at risk or species of conservation concern. In the unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of fish presence. Potential effects will be similar to those described above for secure species. Negligible oil on the sediments was predicted by the model (0.02 percent), and therefore a large-scale direct effect on benthic fish habitat is not anticipated. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low (Section 16.3). In an actual event, emergency response measures would be implemented to limit the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, the potential effects of a subsurface blowout at the EL 1150 site on marine fish and fish habitat are predicted to be adverse, medium in

magnitude, medium to long-term in duration, occurring within the RSA, and reversible. This was determined with a moderate level of confidence.

16.6.2.3 Summary and Determination of Significance

Table 16.17 provides a summary of predicted residual environmental effects of accidental event scenarios for marine fish and fish habitat. Residual effects incorporate the conservative approach used during spill modelling and the implementation of mitigation measures to prevent and reduce effects from any such spill.

Table 16.17 Summary of Residual Accidental Event-Related Environmental Effects on Marine Fish and Fish Habitat

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: • Change in habitat availability and quality • Change in food availability and quality • Change in fish mortality, injury, health, and • Change in fish presence and abundance (behavioral effects)							
100 litre Diesel Spill	A	N-L	L-PA	S	N-O	R	H
1,000 litre Diesel Spill	A	L-M	L-PA	M	N	R	M
750,000 litre Diesel Spill	A	L-M	RSA	M	N	R	M
Drill Fluid (SBM) Spill	A	N-L	L-PA	S	N	R	H
Subsurface Blowout – EL 1144 Example Well Site	A	M	RSA	M-L	N	R	M
Subsurface Blowout – EL 1150 Example Well Site	A	M	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
N Negligible
L Low
M Medium
H High

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Duration:
S Short term
M Medium term
L Long term

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Geographic Extent: L Localized PA Within Project Area LSA Within LSA RSA Within RSA or Beyond			P Permanent Reversibility: R Reversible I Irreversible				

In consideration of marine fish and fish habitat occurrence in the RSA, spill modelling scenarios, and planned mitigation, the predicted residual environmental effects from an accidental event scenario on marine fish and fish habitat (including species at risk) are predicted to be not significant.

In the unlikely event of an offshore hydrocarbon release, residual adverse effects to marine fish and fish habitat in the area at the time of the accident or malfunction are expected. The type and level of any effects would be dependent on such factors as the degree of exposure, spill type and size, time of year, and species presence and occurrence within the affected area. Potential adverse residual effects may result in decline or change to food availability and quality with implications for higher trophic levels. Interactions with hydrocarbons would also result in sublethal and lethal mortality on fish and invertebrates depending on the species-specific responses and degree of interaction. These potential effects would be similar for both secure and at-risk species.

For the duration of any accidental offshore hydrocarbon release, there would be reductions in availability or access to fish habitat. The eventual break down of hydrocarbon material in the water column and surface may become transported to benthic habitats through sinking and flocculation. This pathway would allow for contamination of deep sea environments and potential hydrocarbon interactions with sensitive coral and sponge species. In the context of a batch spill, the potential residual effects would be greatly reduced due to the limited quantities released and therefore localized nature of the such an event.

In the context of applied mitigations, adverse environmental effects are considered unlikely and are not likely to result in an overall detectable decline in population-level fish abundance or change in the spatial and temporal distribution of fish populations in the RSA. It is also unlikely that the overall abundance, distribution or health of any species at risk and its eventual recovery will be negatively affected. With applied mitigations, these unlikely adverse environmental effects are not predicted to have significant effects on fish and fish habitat. Spill prevention techniques and response measures will be incorporated into the design and operations for all Project activities as part of contingency planning. This planning will further help ensure that effects do not occur, and in the unlikely event of an occurrence, that these events would not have significant adverse effects to fish populations and fish habitats in the RSA.

16.6.3 Marine and Migratory Birds (including Species at Risk)

A variety of avifauna species occur within the marine and coastal environments off Eastern Newfoundland at various times of the year, as described in Section 6.2. These include seabirds as well as other avifauna that inhabit offshore and nearshore regions for breeding, feeding, migration and other activities according to their individual life histories and habitat requirements, and could therefore be present in the RSA at the time of an accidental event. Seabirds, waterfowl and divers, and shorebirds are the most vulnerable to perturbation as they spend much of their life in the marine environment;

however, certain landbird species may also be affected, particularly those associated with coastal habitats and any that migrate nocturnally over offshore waters. The timing of species presence and overall density can vary considerably depending on the species, with some taxa abundant year-round (such as large gulls and kittiwakes, many alcid species, fulmars, and shearwaters) while some are more likely to be present in the winter (Ivory Gulls, waterfowl) or fall (Leach's Storm-petrels). Several nesting colonies and important habitats (IBAs and MBSs) for birds have also been identified at locations along the eastern coast of Newfoundland and Labrador; as well, there are several EBSAs in the Northwest Atlantic designated in part due to their importance to seabirds.

The description of the existing environment for marine and migratory birds in this EIS, while regional in nature, has focused primarily on the Eastern Newfoundland Offshore Area and immediately adjacent marine environments, as it is within this area that any Project-related environmental interactions and effects would most likely occur. General information on birds and any key areas in the larger surrounding region is available for reference, as required, through the various SEAs completed by the C-NLOPB, including recent SEA updates for Western Newfoundland (Amec 2014) and Southern Newfoundland (C-NLOPB 2010, 2015).

The accidental release of hydrocarbons in the marine environment has the potential to adversely affect marine and migratory birds and their habitats in the offshore environment and, potentially, in the nearshore environment. The extent of these potential effects depends on several factors, including the location, magnitude and trajectory of the spill, the time of year, and the presence and abundance of marine and migratory birds in the area.

16.6.3.1 Potential Issues and Interactions

As outlined in Chapter 9, the key potential environmental effects included in the assessment of planned Project components and activities included:

- Change in mortality / injury levels and bird health
- Change in avifauna presence and abundance (behavioral effects)
- Change in habitat availability and quality
- Change in food availability or quality

These potential effects remain relevant to the assessment of accidental events; however, the contributing Project-related environmental change (the mechanism of the effect) may differ. Effects of accidental releases on avifauna prey are detailed in Section 16.6.2 (marine fish and fish habitat).

Existing Knowledge of the Effects of Hydrocarbons on Marine and Migratory Birds

Accidental events such as oil spills can have important, adverse consequences for marine-associated birds, leading to potential changes in their presence, abundance, distribution and/or health at both the individual and population level. Marine birds are amongst the biota most at risk from oil spills, as they spend much of their time upon the surface of the ocean (LGL Limited 2005; Barron 2012; Boertmann and Mosbech 2011). In the event of a spill, and depending upon project and area specific factors, coastal birds may also be at risk on beaches and in intertidal zones.

Accidental discharges of hydrocarbons may lead to sheens of crude oil and other substances on the water's surface, to which avifauna (especially pelagic seabirds) may be exposed (Wiese and Robertson 2004; O'Hara and Morandin 2010; Morandin and O'Hara 2016). The possible physical effects of oil exposure on birds include changes in thermoregulatory capability (hypothermia) and buoyancy (drowning) due to feather matting (Clark 1984; Montevecchi et al 1999), as well as potential toxicity effects from oil ingestion through excessive preening (Hartung 1995). Birds that feed on organisms from affected areas are also at heightened risk of contamination from their food sources (Engelhardt 1983). Even small quantities of oil from sheens have been shown to affect the structure and function of seabird feathers (O'Hara and Morandin, 2010), which has the potential to result in water penetrating the plumage and displacing the layer of insulating air. This can result in loss of buoyancy and hypothermia, which can cause a heightened metabolic rate (increased energy expenditure) and behavioral changes (e.g., increased time spent preening at the expense of foraging and breeding), which can potentially cause death of affected individuals (Morandin and O'Hara 2016). The long lifespan and low fecundity of many seabird species suggests that oil-related effects can potentially have longer term population effects (Wiese and Roberston 2004). While the primary exposure potential for, and resulting direct effects, on seabirds would occur within the spatial extent of a spill, the ecological effects of oiled areas may be transported from the affected site due to the highly mobile nature of marine-associated avifauna (Henkel et al 2012).

Morandin and O'Hara (2016) reviewed several short- and long-term studies of marine oil spills and found that effects can result in increased mortality rates, physiological impairment, reduced reproductive success and in severe cases, possible long-term population declines. Once birds are exposed to oil, even with rescue and cleaning efforts, the chances of survival are often quite low (French-McCay 2009). If direct exposure to spilled oil is conservatively assumed to result in close to 100 percent mortality of affected birds, then the key factor in predicting the total extent of mortality of marine birds becomes the probability of exposure. Probability of exposure is dependent on the fate and behavior of the released oil, as well as the distribution and behaviour of the taxa involved; for example, aerial species migrating through the site of a spill are unlikely to become oiled, whereas species that may forage in the spill site are likely to become oiled. Birds at greatest risk are those that spend considerable time resting or foraging on the water surface (Wiese and Roberston 2004; Boertmann and Mosbech 2011). Vulnerability indices of various taxa have been developed by French-McCay (2009), as follows:

- 99 percent mortality for birds that sit on the surface (e.g., dovekies, murres)
- 35 percent mortality for birds that are mostly in flight, but dive frequently for prey (e.g., petrels, terns)
- 5 percent mortality for birds that are mostly in flight, such as migratory landbirds in transit.

The potential effects of oil exposure on birds also varies with different types of oil (Gorsline et al 1981), weather conditions, season, migratory patterns, and other activities (Wiese et al 2001; Montevecchi et al 2012). Mortality rates and potential changes in bird populations due to accidental releases of oil are poorly known; however, it is often cited as the main risk to marine birds from the offshore oil and gas industry (Fraser and Ellis 2008; Ellis et al 2013). Seabirds are generally long-lived and have very low annual reproductive rates. Therefore mortality in adults can have serious effects on populations. Although it is difficult to assess the direct relationship between volume of oil spilled and number of seabirds oiled (Burger 1993), it is clear that the timing and location of a spill (and not just its size) has an important influence on avifauna mortality and injury rates (Weise et al 2001).

The potential for toxic effects from small amounts of ingested oil by seabirds is somewhat unclear. While acute toxic effects from exposure to sheens are considered unlikely (Morandin and O'Hara 2016) and some studies have shown little or no effects from exposure (ingestion) to low doses of oil on adult seabirds (Ainley et al 1981; Stubblefeld et al 1995; Alonso-Alvarez et al 2007), other studies have shown both lethal and sublethal effects of oil exposure on adult birds (Miller et al 1980; McEwan and Whitehead 1980; Trivelpiece et al 1984; Butler et al 1986, 1988). Effects of ingested oil on birds have been found to include liver damage (Khan and Ryan 1991), pneumonia (Hartung and Hunt 1966), brain damage (Lawler et al 1978) and immunotoxic effects (Barron 2012), in addition to starvation due to increased energy needs to compensate for heat loss resulting from oiling and loss of insulation (Peakall et al 1980; 1982; MMS 2001).

Existing Knowledge of the Effects of Dispersants on Marine and Migratory Birds

The use of dispersants is beneficial for marine and migratory birds in that it reduces the potential for exposure to floating oil (and, thus, the risk of adverse effects) on the sea surface within the spill area. The measured toxicity of dispersants themselves is very low (Prince 2015). Application of chemical dispersants results in a far greater rate of biodegradation of oil, reducing the duration to a matter of weeks rather than of years (Baelum et al 2012). Further, this relatively rapid rate of degradation greatly reduces the chance of accidentally released oil reaching shorelines where it could potentially cause great harm to shorebirds and seabird nesting colonies (Prince 2015). Conversely, however, the use of dispersants results in increased oil within the water column, potentially resulting in exposure of food sources (fish and water column invertebrates) to oil, and exposure of diving birds to the dispersed oil. Dispersed oil has similar effects to that of untreated oil, but the size of the slick and exposure concentrations would be lower than non-dispersed oil. Hence, dispersant mitigates the potential adverse effects of oil on birds compared to untreated oil.

Existing Knowledge of the Effects of Drill Fluids (SBMs) on Marine and Migratory Birds

A SBM spill from the surface would likely result in a surface sheen similar to what has been described for batch spills but more limited in nature. The possible physical effects of SBM exposure on birds would be similar to other hydrocarbons and would include changes in thermoregulatory capability (hypothermia) and buoyancy (drowning) due to feather matting (Clark 1984; Montevecchi et al 1999), as well as potential toxicity effects from oil ingestion through excessive preening (Hartung 1995). Birds that feed on organisms from affected areas are also at heightened risk of contamination from their food sources (Engelhardt 1983). Similar to hydrocarbon exposure, the primary potential for exposure, and resulting direct effects, on seabirds would occur within the spatial extent of a spill, the ecological effects of oiled areas may be transported from the affected site due to the highly mobile nature of marine-associated avifauna (Henkel et al 2012). SBMs, however, are a heavy, dense fluid which sink rapidly and the effects on the water's surface would be limited compared to marine diesel or crude oil spills.

16.6.3.2 Environmental Effects Assessment

The potential environmental effects of an accidental hydrocarbon release on marine and migratory birds are assessed in the following subsections.

Marine Diesel Spills (Batch Spills and Vessel Collision Scenario)

The relevant model results for marine diesel spills (100 L, 1,000 L, 750,000L) are summarized in Section 16.4. Any batch spills resulting from the Project would cause a temporary decrease in water (and thus habitat) quality around the spill site. This would be short-term in nature, lasting until the slick disperses when aided by surface wave action in the offshore environment. The model results suggest that both the potential for exposure and the likelihood of adverse effects on marine and migratory birds from a batch release are low, with only those individuals occupying the immediate footprint of the spill at the time of the spill being affected.

Based on observations of sheens in Atlantic Canada are industry-reported to C-NLOPB, between 2003 and 2014, the average annual number of reported sheens near platforms on the Grand Banks was 24 (Morandin and O'Hara 2016). Based on the perceived colour of these sheens, the thickness was estimated to be in the range of 0.00007 to 0.001 mm (where quantitative descriptions were provided), and it is thought that thicker sheens are rare in offshore operations (Morandin and O'Hara 2016). Sheen persistence is related to thickness; data from ERIN Consulting Ltd and OCL Services Ltd (2003) for example showed that sheens of 0.001 mm persisted for up to 24 h, while thinner (0.0001 mm) sheens tended to disperse in less than an hour.

If a sheen was produced from a Project-related batch spill, it would be temporary (likely less than 24 hours) and limited in size, affecting only birds in the immediate area of the spill itself. There would be an increased risk of mortality for individual birds that physically encountered the sheen, particularly for diving birds and those that spend large amounts of time on the water. Potential sublethal toxicity effects on metabolic rate and chick growth in marine birds is also possible; chicks and eggs are more susceptible to negative effects of exposure to oil even at very low levels). Exposure of breeding adults (and, consequently, eggs and nestlings) of most seabirds to hydrocarbon sheens within or near the Project Area is unlikely because the Project Area is several hundred kilometers from shore, well outside the foraging range of most seabirds; however, the Leach's storm-petrel is known to make foraging trips of thousands of kilometers during the breeding season (Pollet et al 2014), and therefore breeding adults may be exposed to hydrocarbon emissions while foraging within the affected area within 24 hours of the spill. The northern gannet is also known to make extensive multi-day foraging trips (Garthe et al 2007). This has the potential to result in changes in avifauna presence and abundance (behavioral effects), as hydrocarbon exposure could influence the occurrence and success of key life history stages of these species.

A potential marine diesel spill from a Project-related MODU or supply vessel, although an undesirable and environmentally important occurrence, would be prevented or responded to through various mitigation measures outlined previously and would therefore be limited in terms of its overall magnitude, extent and duration, and thus, its potential environmental consequences. Therefore, any such spills, in the unlikely event that they did occur, would be limited in terms of the magnitude, spatial, and temporal nature of the sheen and thus the number of birds that would be affected through direct interaction.

With spill prevention plans and response procedures in place, potential effects of a marine diesel spill (100 L, 1,000 L, 750,000L) on marine and migratory birds are predicted to be adverse, low to medium in magnitude, localized to within the RSA in extent, short- to medium-term in duration, and reversible. This prediction was made with an overall moderate level of confidence.

Drill Fluid (SBM) Spill

The relevant drill fluid model results are summarized in Section 16.5. A spill of drill fluids can potentially result in similar effects described for a marine diesel spill. SBMs, however, are a heavy, dense fluid which sinks rapidly so the effects on the water's surface would be more limited than diesel or crude oil spills as it sinks through the water column. Potential effects of a drill fluid spill on marine and migratory birds are predicted to be adverse but negligible to low in magnitude, short-term in duration, localized to within the Project Area, and reversible. This was determined with a high level of confidence.

Uncontrolled Well Event

The relevant model results for uncontrolled well events are summarized in Section 16.4. An uncontrolled well event, or subsurface blowout, can potentially result in a change in mortality or injury level and bird health (individuals or populations), change in avifauna presence and abundance (behavioural effects), change in habitat availability and quality, and / or change in food availability or quality. As part of this assessment, the ecological risk to marine birds was assessed by using the species vulnerability metrics (Section 16.6.3.1) in combination with ecological/marine bird threshold concentrations for the oil floating on the surface (10 g/m², 10µm thickness) and shoreline oil (100 g/m²). The main potential effect on seabirds is through direct contact with oil.

Generally, the greatest risk of seabird interactions with an oil spill comes in the winter months when conditions are colder and thermoregulation is most difficult, increasing the likelihood of mortality for affected birds (Morandin and O'Hara 2016). However, for any given species, the risk of interaction with an oil spill varies with the species' abundance in the area, which in turn depends on the season; for example, Northern gannets and Leach's storm-petrels are at greatest risk in the fall, when young fledglings depart the colony for rich offshore feeding grounds. Fledgling common murres and thick-billed murres are also vulnerable at this time of year, as chicks are flightless for a period of one to two months as they accompany their male parent to foraging areas. As detailed in Chapter 9, the waters off Atlantic Canada provide important wintering habitat for a number of species, including great skua, dovekie, black-legged kittiwakes and common and thick-billed murre. Most of the world's great shearwaters are found in the northwest Atlantic during the summer months (i.e., the non-breeding season for this southern hemisphere species).

EL 1144 Example Well Site

Based on the vulnerability indices (French-McCay 2009), the mortality risk would range from 35-99 percent for birds that come in contact with slick in the 0.01-0.1 mm thickness range. Murres and dovekies, which spend most of their time sitting on the water's surface, are most vulnerable (estimated 95 percent mortality), while species that dive or feed at the water's surface for their prey but otherwise spend little time on the water, includes Leach's storm-petrels, great shearwaters, and great skuas, are predicted to have a lower mortality rate of 35 percent. Black-legged kittiwakes and northern gannets, which do often sit on the water but spend more time in the air than alcids (murres and dovekies), would be expected to have an intermediate mortality rate.

While the consequences of shoreline oil exposure would be serious for marine birds, shoreline exposure in the summer months is unlikely with the highest predicted potential being one to less than three percent in the event of an unmitigated subsurface release scenario. Sable Island is a bird sanctuary

and a breeding area for the Roseate Tern, a SARA species listed as endangered. The probability of oil reaching Sable Island is very small (less than three percent in the stochastic modelling; 99th percentile deterministic) with a long response time (over 52 days for first shoreline contact after spill), increasing the ability to put mitigations in place to further reduce the chances of oil-shoreline interaction.

As noted in Section 6.2.6 there are two marine-associated avian species at risk that are known to occur in the in the LSA and/or RSA, and several others that are associated with coastal habitats in Newfoundland and Labrador. Within offshore Nova Scotia, there are seven marine bird species and two coastal species that breed on Sable Island which are listed as either species at risk or species that are otherwise of conservation concern (BP 2016), seven of which are also discussed in Section 6.2.6. In the unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time of presence of marine-associated avian species at risk. Potential effects will be similar to those described above. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low (Section 16.3). In an actual event, emergency response measures would likely be effective in limiting the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, including the implementation of shoreline protection measures, potential effects of a subsurface blowout from the EL 1144 site on marine and migratory birds are predicted to be adverse, potentially medium to high in magnitude, medium to long-term in duration, occurring within the RSA, and reversible. This was determined with a moderate level of confidence.

EL 1150 Example Well Site

Based on the vulnerability indices (French-McCay 2009) the estimated mortality risk would again range from 35-99 percent (the latter percentage for birds sitting on the water surface such as murres and dovekies, and the former for diving birds such as storm-petrels, shearwaters and skuas) for the birds that come in contact with a slick in the 0.01-0.1 mm thickness (Appendix G).

As noted in Section 6.2.6, there are two marine-associated avian species at risk that are known to occur in the LSA and/or RSA, and several others that are associated with coastal habitats in Newfoundland and Labrador. With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the EL 1150 site on marine and migratory birds are predicted to be adverse, potentially medium to high in magnitude, medium to long-term in duration, occurring within the RSA, and reversible. This was determined with a moderate level of confidence.

16.6.3.3 Summary and Determination of Significance

Each of the potential accidental events that have been identified and are assessed, including possible diesel spills and blowouts, have the potential to adversely affect marine birds that come into contact with them. However, the potential for, and possible magnitude of, any such effects will depend on the specific nature, degree and other characteristics of the event, inducing the type and quantity of material spilled, its eventual geographic extent, and the persistence of these materials in the environment.

As noted throughout, the modelled oil spill fate and behavior, and associated effects analysis provided above, relate to the probability of an unmitigated blowout scenario occurring and interacting with marine-

associated avifauna and their habitats. The modeling is therefore itself inherently conservative, in that such a blowout event is both unlikely (Section 16.3), and would be avoided or addressed through various oil spill prevention and response measures committed to by Nexen in Section 16.1 and required under subsequent (post-EA) regulatory approval processes for the drilling program. These mitigations, including response measures such as the use of dispersants or other means, will serve to prevent or reduce any adverse effects on marine-associated avifauna including the magnitude, extent and duration of any such exposure (if it occurs) and thus its potential environmental effects.

Table 16.18 provides a summary of predicted residual environmental effects of accidental event scenarios for marine and migratory birds. Residual effects incorporate the conservative approach used for the spill modelling and consider the implementation of mitigation measures to prevent and reduce effects from a spill.

Table 16.18 Summary of Residual Accidental Event-Related Environmental Effects on Marine and Migratory Birds

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: • Change in mortality / injury levels and bird health • Change in avifauna presence and abundance (behavioral effects) • Change in habitat availability and quality • Change in food availability or quality							
100 litre Diesel Spill	A	L	L-PA	S	N-O	R	H
1,000 litre Diesel Spill	A	M	PA-LSA	M	N	R	M
750,000 litre Diesel Spill	A	M	RSA	M	N	R	M
Drill Fluid (SBM) Spill	A	N-L	L-PA	S	N	R	H
Subsurface Blowout – EL 1144 Example Well Site	A	M-H	RSA	M-L	N	R	M
Subsurface Blowout – EL 1150 Example Well Site	A	M-H	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
N Negligible

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence
N/A Not Applicable

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
L Low M Medium H High Geographic Extent: L Localized PA Within Project Area LSA Within LSA RSA Within RSA or Beyond			Duration: S Short term M Medium term L Long term P Permanent Reversibility: R Reversible I Irreversible				

In consideration of the present knowledge of marine and migratory bird occurrence in the RSA, the known effects of oil spills on marine-associated avifauna, the result of spill modelling exercises, and planned mitigation, a precautionary conclusion is drawn that residual environmental effects from an accidental subsurface blowout on marine and migratory birds could potentially be significant depending on the specific occurrence, and nature and degree of the event, but are unlikely to occur. Spill response and prevention strategies will be incorporated into the Project as part of contingency planning, thus ensuring the likelihood and potential severity of such events, and their potential effects on the VC, is minimized.

In the unlikely event of a large scale offshore hydrocarbon release, residual adverse effects to marine and migratory birds present in the area, including SAR, are expected. The magnitude of these effects would depend on the size and duration of the spill, location, time of year, and species presence and abundance within the affected area. For a blowout scenario, environmental effects could be significant, resulting in a detectable decline in overall bird abundance or change in the spatial and temporal distribution of bird populations in the overall RSA for multiple generations. However, this is considered unlikely given the very low probability of a large spill to occur, and in consideration of the response measures that will be implemented. Birds are highly mobile; therefore, presence and abundance within the Project Area (and the RSA) are variable, as, consequently, is the likelihood of interaction with Project-related accidental events.

16.6.4 Marine Mammals and Sea Turtles (including Species at Risk)

As described in Chapter 10, various species of marine mammals and sea turtles have been reported in the RSA, including several that are considered to be at risk or otherwise of special conservation concern. Therefore, there is the potential for them to be present during, and thus affected by, an accidental event. Overall abundance of marine mammals is highest from late spring to autumn, but some species may be present year-round. Small-toothed whale, dolphin, and porpoise species are expected in both coastal and offshore waters of the RSA, whereas sperm whale sightings are more often associated with continental slope waters. The most commonly expected baleen whale species in the RSA are humpback, minke, fin, and sei whales. Harbour seals are concentrated primarily in coastal areas, while grey, harp, and hooded seals are more widespread and can be found in deeper waters of the RSA when not breeding or whelping on land or pack ice. Just one sea turtle species is regularly found in the area; the Leatherback occurs in Eastern Newfoundland waters from April to December. No designated critical habitat for marine mammals or sea turtles is present within or near the RSA, but there are several EBSAs that overlap with, or are in close proximity to, the Project Area. These EBSAs are important feeding and seasonal refuge areas for marine mammals and sea turtles (Chapter 10).

The likelihood and severity of potential interactions with accidental effects (specifically, hydrocarbon releases) on marine mammal and sea turtle species are very much dependent on several factors, such as the time of year, duration and volume of the spill, and its location relative to species' preferred habitats.

16.6.4.1 Potential Issues and Interactions

As outlined in Chapter 10, the key potential environmental effects included in the assessment of planned Project components and activities included:

- Change in mortality / injury levels and health (individuals or populations)
- Change in habitat availability, quality and use (behavioral effects)
- Change in food availability or quality

These potential interactions and effects are relevant to assessment of accidental effects; however, the contributing Project-related environmental change (the mechanism of the effect) may differ, as described in the sections that follow.

Existing Knowledge of the Effects of Hydrocarbons on Marine Mammals and Sea Turtles

Potential adverse effects to marine mammals and sea turtles resulting from an accidental hydrocarbon release include potential oiling of fur, baleen, skin and flippers; ingestion of contamination in food and water; reduction in prey availability; and potential inhalation of volatiles through respiration. Depending on the level of exposure, these effects can result in behavioural changes, physiological and neurological damage, challenges to movement, or death.

The primary pathways through which oil spills may directly affect marine mammals and sea turtles are ingestion, absorption and inhalation. Direct evidence is lacking for long-term effects from exposure to hydrocarbons through contact or ingestion for marine mammals and sea turtles, although long-term studies have demonstrated evidence implicating oil spills with the mortality of cetaceans (Dahlheim and Matkin 1994; Matkin et al 2008). Seals and cetaceans have a thick layer of subcutaneous fat (blubber) which serves a thermoregulatory function; therefore, contact with oil has little effect on thermoregulation compared to that observed in seabirds (Geraci 1990). However, irritation and increased susceptibility to infection can occur with skin exposure, particularly in the sensitive membranes of the eyes and mouth (Perrin et al 2002). Oil can also coat baleen, causing a temporary reduction in feeding efficiency of mysticetes (Geraci 1990).

Inhalation and aspiration of aerosolized and volatile oil compounds can result in inflammation of the mucous membranes and absorption of hydrocarbons into the bloodstream (Geraci 1990). Cetaceans may also ingest oil with water or by consuming contaminated prey. Ingested oil can be absorbed into the tissues and have toxic effects (Geraci 1990); for example, top-level predators such as killer whales are known to be susceptible to accumulating high concentrations of persistent organic pollutants (Ross et al 2000, 2002). However, ingested oil may eventually leave the system when an organism returns to uncontaminated waters (Engelhardt 1978, 1982, 1983). For example, only small traces of oil were found in grey whale blubber and in the liver of a killer whale exposed to oil from the Exxon Valdez spill (Bence and Burns 1995). While there is some evidence suggesting that cetaceans may be able to detect oil spills, most species do not tend to exhibit avoidance behaviours (Geraci et al 1983, St. Aubin et al 1985,

Harvey and Dahlheim 1994, Matkin et al 1994). Smultea and Würsig (1995) did observe that dolphins tended to decrease respiration rate and increase dive durations in the presence of surface oil.

The 2010 DWH spill is probably the most-studied oil spill to date; however, it occurred in waters warmer than those of the RSA, and therefore direct comparisons of the effects of this spill cannot always be made. Nonetheless, many of the effects are expected to be similar, and because so many marine mammal and sea turtle species have extremely large ranges, many of the same species affected by the DWH spill occur within the Project Area and RSA. NMFS (2014) reported that following the DWH spill in the Gulf of Mexico, 171 dolphins and whales were collected through stranding or directed captures in open water, of which 153 individuals were collected dead. Almost 90 percent of these mortalities were bottlenose dolphins and about five percent showed visible oiling (NMFS 2014). A significant reduction of reproductive success and increase in calf mortality in the common bottlenose dolphin following the Deepwater Horizon oil spill was observed by Lane et al (2015).

Exposure to oil may result in mortality of some pinnipeds; in particular, pups appear to be most vulnerable in colder waters (St. Aubin 1990). Temporary or even permanent damage to sensitive eye tissues has been reported (St. Aubin 1990; Spraker et al 1994) which results in reduced foraging efficiency (Levenson and Schusterman 1997). With heavy oil exposure, seals may experience difficulty with locomotion (Davis and Anderson 1976, Sergeant 1991). Harbour seals observed immediately after oiling from the Exxon Valdez spill appeared lethargic and disoriented, which was thought to be attributed to lesions that were subsequently found in the thalamus of the brain (Spraker et al 1994). Oil ingested from contaminated prey or even from nursing contaminated milk may be absorbed into the tissues, resulting in kidney, liver, and brain lesions (Geraci and Smith 1976, Spraker et al 1994).

Sea turtles surface to breathe, and because they do not appear to show avoidance of oil spills and take large inhalations prior to diving, they may be particularly susceptible to inhalation of volatiles (Vargo et al 1986; NOAA 2010; Vander Zanden et al 2016). The effects of inhalation of oil by sea turtles include a reduction of lung capacity and decreased oxygen uptake (Lutz and Lutcavage 1989). Ingestion and absorption of oil can also occur from both surfacing and ingestion of oiled prey which may lead to reduced digestion efficiency and damage to sensitive tissues such as eyelids and nasal passages (Lutz and Lutcavage 1989). Temporary skin damage (lesions) has been observed in loggerhead sea turtles following exposure to oil, with healing of lesions observed within ten days post-exposure (Bossart et al 1995). Following the 2010 DWH spill, Beyer et al (2016) reported an increase in sea turtle strandings, particularly Kemp's ridley turtles, while NMFS (2014) documented at least 18 visibly oiled dead turtles and an additional 450 rescued and rehabilitated sea turtles, 95 percent of which were loggerhead sea turtles.

Existing Knowledge of the Effects of Dispersants on Marine Mammals and Sea Turtles

The use of dispersants, which enhance the natural microbial degradation, may be beneficial for marine mammals and sea turtles within a spill area by reducing the sea surface exposure to oil and results in a far greater rate of biodegradation of oil to a matter of weeks rather than of years (Baelum et al 2012). This relatively rapid rate of degradation greatly reduces the chance of accidentally released oil reaching shorelines (Prince 2015). Further, the measured toxicity of dispersants themselves is very low (Prince 2015). Therefore, use of dispersants is predicted to reduce potential adverse environmental effects on marine mammals and sea turtles. However, use of dispersants may expose marine mammals and sea turtles to a greater amount of oil in the water column, and thus a greater likelihood of oiled skin or fur,

ingestion of contaminated food sources (such as fish and water column invertebrates), and potential clogging of baleen (Lee et al 2015). Ingested hydrocarbons can be metabolized and excreted by marine mammals; however, some may be stored in fat deposits and ultimately released into circulation during periods of physiological stress such as low food availability, migration and lactation. These hydrocarbons may become bioavailable and potentially toxic to the individual and its young (Lee et al 2015).

Existing Knowledge of the Effects of Drill Fluids (SBMs) on Marine Mammals and Sea Turtles

The possible physical effects of SBM exposure on marine mammals and sea turtles would be similar to other hydrocarbons described above. SBMs, however, are a heavy, dense fluid which sinks rapidly so the effects on the water's surface and water column would be more limited than other hydrocarbon spills.

16.6.4.2 Environmental Effects Assessment

The potential environmental effects of an accidental hydrocarbon release on marine mammals and sea turtles are assessed in the following subsections. Note that in both the batch spill and blowout scenarios, pinnipeds (i.e., seals) are at higher risk of adverse effects of oil exposure than cetaceans and sea turtles, and may encounter oil either in the water or when hauling out on oiled shorelines.

Marine Diesel Spills (Batch Spills and Vessel Collision Scenario)

The relevant model results for diesel spills (100 L, 1,000 L, 750,000L) are summarized in Section 16.4. The results of the models suggest that both the potential for exposure and the likelihood of adverse effects on marine mammals and sea turtles from a batch release (e.g., fouling, inhalation of vapours) are low. Only animals in the immediate vicinity at the time of the spill may be exposed, and at the concentrations predicted, change in mortality or injury is considered unlikely and changes in health are predicted to be of low magnitude (e.g., temporary inflammation of mucous membranes). Changes in habitat quality or use will likewise be of low magnitude. Batch spills are not expected to affect haulout areas on distant shorelines. While there will be a decrease in water quality around the spill site, this would be short-term until the slick disperses (aided by surface wave action in the offshore environment).

With spill prevention plans and response procedures in place, potential effects of a diesel spill (100 L, 1,000 L, and 750,000 L) on marine mammals and sea turtles are predicted to be adverse, negligible to medium in magnitude (depending on spill size), short to medium term in duration, localized to within the RSA, and reversible. This was determined with an overall moderate level of confidence.

Drill Fluid (SBM) Spill

The relevant drill fluid model results are summarized in Section 16.5. SBMs are a heavy, dense fluid which sinks rapidly so the effects on the water's surface would be more limited than diesel or crude oil spills. Potential effects of a drill fluid spill on marine mammals and sea turtles are predicted to be adverse, negligible to low in magnitude, short-term in duration, localized to within the Project Area, and reversible. This was determined with a high level of confidence.

Uncontrolled Well Event

The relevant model results for uncontrolled well events are summarized in Section 16.5. An uncontrolled well event, or subsurface blowout, can potentially result in a change in mortality or injury of individuals, change in health, change in habitat quality / availability or use, and change in food availability. The potential for effects would be greatest near the location of the hydrocarbon release, and will depend on the distribution and abundance of marine mammals and sea turtles in the area at the time of the release. The magnitude of the effects will increase with the volume and duration of hydrocarbon release. Results of modelling for potential subsurface blowout scenarios are discussed below.

As noted, effects are predicted to be low to medium magnitude and short to medium-term in duration depending on the nature of the spill. The degree of change in mortality or injury and change in health will depend in large part on the occurrence and distribution of marine mammals and sea turtles at the time of the blowout, as well as the duration and extent of oil release. Given the highly mobile nature of this VC, the magnitude of effects will be higher for subsurface releases of larger scale and extended duration, similar to that observed during the DWH spill in the Gulf of Mexico (e.g., Takeshita et al 2017). Depending on the exact nature, extent, and duration of a spill, marine mammals and sea turtles in the spill area are likely to experience a combination of exposures from contaminated air, water, and sediment and therefore via a combination of pathways (inhalation, ingestion, aspiration, and adsorption). Marine mammals and sea turtles that are closer to the site of the blowout are more likely to be exposed to a more constant flow and higher concentrations of oil, as compared to nearshore species.

EL 1144 Example Well Site

In this scenario, species that haulout on potentially affected shorelines are those most likely to interact with hydrocarbons (e.g., grey seals on Sable Island). In the unlikely event of shoreline oiling, fur-bearing marine mammals that haulout in the affected area may experience a change in mortality or injury and a change in health upon exposure to hydrocarbons, although it is probable that only a small proportion of local populations would be affected. Predatory marine mammals that prey on seals (e.g., killer whales) may also experience changes in mortality, injury, or health following consumption of oiled prey species. Change in habitat quality or use of terrestrial habitats is predicted to be low in magnitude and short-term in duration.

As noted in Section 10.4, there are nine marine mammal and two sea turtle species at risk or species of conservation concern that are known to occur in the LSA and/or RSA. In the unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected if the timing of the spill occurs at the same time as their presence. Potential effects would be similar to those described above. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low (Section 16.3). In an actual event, emergency response measures would likely be effective in limiting the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, any potential effects of a subsurface blowout from the EL 1144 site on marine mammals and sea turtles are predicted to be adverse, low to medium in magnitude, occurring within the RSA, medium to long-term in duration, and reversible. This was determined with a moderate level of confidence.

EL 1150 Example Well Site

As discussed in 16.6.1, the model results exceed the ecological thresholds in the surface and the water column. Releases at EL 1150 were not predicted to make contact with the shore. Change in habitat quality or use of terrestrial habitats is therefore predicted to be low in magnitude and short-term in duration. As noted in Section 10.4, there are nine marine mammal and two sea turtle species at risk or species of conservation concern that are known to occur in the LSA and/or RSA. In the unlikely event of an uncontrolled release into the marine environment, these species have the potential to be adversely affected, if the timing of the spill occurs at the same time as their presence. Potential effects would be similar to those described above. The likelihood, however, of a subsurface blowout occurring with the relevant mitigations in place has been calculated to be extremely low (Section 16.3). In an actual event, emergency response measures would limit the magnitude, duration and extent of the spill.

With spill prevention plans and response procedures in place, any potential effects of a subsurface blowout from the EL 1144 site on marine mammals and sea turtles are predicted to be adverse, low to medium in magnitude, occurring within the RSA, medium to long-term in duration, and reversible. This was determined with a moderate level of confidence.

16.6.4.3 Summary and Determination of Significance

Table 16.19 provides a summary of predicted residual environmental effects of accidental event scenarios on marine mammals and sea turtles.

Table 16.19 Summary of Residual Accidental Event-Related Environmental Effects on Marine Mammals and Sea Turtles

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: • Change in mortality / injury levels and health (individuals or populations) • Change in habitat availability, quality and use (behavioral effects) • Change in food availability or quality							
100 litre Diesel Spill	A	N-L	L-PA	S	N-O	R	H
1,000 litre Diesel Spill	A	L	L-PA	S	N	R	M
750,000 litre Diesel Spill	A	L-M	RSA	S-M	N	R	M
Drill Fluid (SBM) Spill	A	N-L	L-PA	S	N	R	H
Subsurface Blowout – EL 1144 Example Well Site	A	L-M	RSA	M-L	N	R	M
Subsurface Blowout –	A	L-M	RSA	M-L	N	R	M

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
EL 1150 Example Well Site							

KEY

Nature / Direction:
- P Positive
- A Adverse
- N Neutral (or No Effect)

Magnitude:
- N Negligible
- L Low
- M Medium
- H High

Geographic Extent:
- L Localized
- PA Within Project Area
- LSA Within LSA
- RSA Within RSA or Beyond

Frequency:
- N Not likely to occur
- O Occurs once
- S Occurs sporadically
- R Occurs on a regular basis
- C Occurs continuously

Duration:
- S Short term
- M Medium term
- L Long term
- P Permanent

Reversibility:
- R Reversible
- I Irreversible

Certainty in Predictions:
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence
- N/A Not Applicable

An accidental event from the Project is not likely to result in significant adverse environmental effects on marine mammal and sea turtles, including species at risk. This conclusion has been reached with a moderate to high level of certainty based on current understanding of the effects of similar projects on the VC, the availability of literature and data used to characterize existing conditions and Project effect mechanisms, and the known effectiveness of proposed mitigation measures (Section 16.1). Spill response and prevention strategies will be incorporated into the Project as part of contingency planning, thus ensuring the likelihood and potential severity of such events, and their potential effects on the VC, are minimized.

In the unlikely event of a hydrocarbon release, residual adverse effects on marine mammals and sea turtles present in the area, including SAR, are expected; however, these are not anticipated to result in a long-term detectable change in abundance or distribution of populations within the RSA. The magnitude of these effects would depend on the size and duration of the spill, location, time of year, and species presence and abundance within the affected area. Marine mammals and sea turtles species are highly mobile, and most show large migration or movement patterns across broad ranges. Therefore, presence and abundance within the Project Area (and the RSA) are variable, as, consequently, is the likelihood of interaction with Project-related accidental events.

16.6.5 Special Areas

Various marine and coastal areas in Newfoundland and Labrador and elsewhere in Eastern Canada have been designated as protected under provincial, federal or other legislation and processes, or have otherwise been identified as being special or sensitive due to their ecological, historical or socio-cultural characteristics and importance. These special areas are valued for environmental, economic and/or socio-cultural reasons, and there are often associated regulatory, stakeholder and Indigenous interests in their intrinsic ecological or anthropogenic value and uses. These areas and their environmental

characteristics may therefore be particularly vulnerable to an accidental event, as any further degradation of their environmental conditions may affect their underlying integrity and value.

The description of the existing environment for special areas in this EIS (Section 6.4) by necessity focused primarily on the Eastern Newfoundland Offshore Area and immediately adjacent marine environments, as it is within this area that Project-related environmental interactions and effects would be most likely to occur. General information on special areas in the larger Atlantic Canada region is available for reference, as required, through the various SEAs completed by the C-NLOPB, including recent SEA updates for Western Newfoundland (Amec 2014) and Southern Newfoundland (C-NLOPB 2015) and the Labrador SEA (Sikumiut 2008, currently being updated), the former also provides regional information and mapping for this VC throughout the Gulf of St. Lawrence region.

As described and mapped in Section 11.3.3, there are a number of special areas offshore Eastern Newfoundland that overlap in whole or in part with the offshore Project Area including various EBSAs, VMEs and NAFO FCAs. Most identified special areas in this region are, however, located on land or in coastal and nearshore areas, well outside of the Project Area and the likely environmental zone of influence of most of the planned components and activities that comprise this Project. Although the Project-specific environmental effects assessment for this VC (Chapter 11) has therefore predicted no potential interactions with these coastal or on land special areas, there is particular concern about the potential for an accidental event such as large oil spill to eventually reach and adversely affect these areas and their key environmental features and processes. These potential issues and interactions are described below.

16.6.5.1 Potential Issues and Interactions

Special areas are often identified and designated as such to recognize their importance and to protect particularly exceptional or sensitive environmental features. In certain cases, this is based on the objective of conserving the presently pristine and ecologically important nature of these areas, while in others their designation is intended to help prevent further damage to already affected and sensitive environmental components. In either situation, these areas and their environmental characteristics may therefore be particularly vulnerable to disturbance and effects, as any further degradation of their environmental conditions may affect the underlying integrity and value of these areas.

As described in the Project-specific environmental analysis for this VC (Chapter 11), the potential effects of offshore oil and gas activities on such special areas may be direct and indirect in nature. Specifically, they may result both from the direct interaction of Project activities and emissions with these areas, as well as by otherwise affecting the marine fish, birds, mammals or other environmental components that move to and through these areas. Whatever the environmental and effects pathways involved, any direct or indirect changes to the existing natural or human environments in such an area as a result of Project-related interactions may affect the key ecological characteristics and processes that define and distinguish these areas, and thus, affect their overall and underlying characteristics, integrity and value. The potential environmental effects on Special Areas identified and used in the earlier effects assessment for planned Project activities (Chapter 11) included:

- Changes in environmental features and/or processes, and
- Changes in human use and/or societal value.

These potential effects remain relevant to the assessment of accidental events. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in both space and time. Potential effects on special areas in the event of an accidental release of hydrocarbons includes the degradation of the ecological integrity of the special area such that it is not capable of providing the same ecological function for which it is designated. The special areas VC is closely linked to the other VCs considered in this assessment, particularly the biological VCs discussed above.

16.6.5.2 Environmental Effects Assessment

The potential environmental effects of an accidental hydrocarbon release on special areas are assessed in the following subsections.

The determination of effects for oil concentrations in the marine environment for special areas required consideration of both ecological and socioeconomic thresholds. However, as the socioeconomic thresholds are lower (0.04 µm oil thickness) and therefore more conservative, these are used in the assessment of potential effects on this VC.

Marine Diesel Spills (Batch Spills and Vessel Collision Scenario)

The relevant spill results for diesel spills (100 L, 1,000 L, 750, 000 L) are summarized in Section 16.4. Based on modelling of batch spills, total hydrocarbon concentrations would be highest in the immediate vicinity of the spill and would be limited in terms of overall magnitude, extent and duration, and thus, their potential adverse environmental consequences. Given that such a spill could conceivably occur at any location within the Project Area, or along the associated vessel and aircraft traffic routes, it is possible that any such spill could overlap with, and to a degree interact with, the identified special areas that are located within these boundaries.

Any such spills, in the event that they did occur, are unlikely to have a detectable effect on any special areas within the Project Area or beyond, and to measurably affect their key environmental and socio-cultural characteristics. With operational spill prevention plans and response procedures in place, potential effects of a diesel spill (100 L, 1,000 L, 750,000 L) on special areas are predicted to be adverse, negligible to medium in magnitude (depending on spill size and location), short- to medium-term in duration, localized to within the RSA and reversible. This was determined with an overall moderate level of confidence.

Drill Fluid (SBM) Spill

A drill fluid (SBM) spill is not predicted to have any detectable adverse effects on special areas based on the modelling results (Section 16.5). This was determined with a high level of confidence.

Uncontrolled Well Event

The relevant model results for uncontrolled well events are summarized in Section 16.4. A subsurface well blowout represents the accidental event with the most potential to affect adjacent Special Areas. This is due to the potentially large amount of discharged oil that could conceivably be associated with a blowout event and the possibility for such a spill to extend to adjacent areas and resources. In addition, a subsurface blowout has the potential to result in changes to environmental features and/or processes,

and changes in human use and/or societal value of special areas. Thus, such an event would be the most widespread and of greatest environmental and socioeconomic concern for this VC.

EL 1144 Example Well Site

Table 16.20 and Figure 16.25 identifies the number of special areas within the predicted 95th percentile for oil in the water column for EL 1144 example well site(Ecological Threshold). The majority of these special areas (NAFO Fisheries Closure Areas, VMEs) are designated due to the relative importance of bottom habitats including coral and sponges. Negligible oil on the sediments was predicted by the model (0.01 percent), and therefore a large-scale direct effect on bottom habitat is not anticipated. However, the two EBSAs do have some components of their designation that related to environmental components and processes above the seabed. For example, both have high seasonal aggregations of cetaceans and pinnipeds. These EBSAs are not predicted to have surface oil thickness above the ecological threshold. A further assessment of marine mammals in relation to an accidental event is detailed in the previous section.

Table 16.20 Summary of Special Areas Overlapping with Modelled Uncontrolled Well Event in EL 1144 Example Well Site

Special Area Type	Name
EBSA	• Northeast Shelf and Slope • Lilly Canyon-Carson Canyon
NAFO Fisheries Closure Area	• Eastern Flemish Cap 4 • Northeast Flemish Cap 5 • Sackville Spur 6 • Northern Flemish Cap 7 • Northern Flemish Cap 8 • Northern Flemish Cap 9 • Northwest Flemish Cap 10 • Northwest Flemish Cap 11 • Beothuk Knoll 13 • Northwest Flemish Cap 12 • Flemish Pass/Eastern Canyon 2
VME	• Beothuk Knoll • Southern Flemish Pass to Eastern Canyons • Flemish Cap East • Northern Flemish Cap • Sackville Spur • Deep Water Coral Area
Note: Overlapping of well event is based on the 95 percent ecological threshold for water column concentrations	

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the EL 1144 example wellsite on special areas are predicted to be adverse, medium in magnitude, medium to long-term in duration, occurring within the RSA and reversible. This was determined with a moderate level of confidence.

EL 1150 Example Well Site

Table 16.21 and Figure 16.26 identify a number of special areas within the predicted 95th percentile for oil in the water column for EL 1150 example well site. These special areas (NAFO Fisheries Closure Areas, VMEs) are designated due to the relative importance of bottom habitats including coral and sponges. Negligible oil on the sediments was predicted by the model (0.02 percent), and therefore a large-scale direct effect on bottom habitat is not anticipated.

Table 16.21 Summary of Special Areas Overlapping with Modelled Uncontrolled Well Event in EL 1150 Example Well Site

Special Area Type	Name
EBSA	• None
NAFO Fisheries Closure Area	• Eastern Flemish Cap 4 • Northern Flemish Cap 7 • Beothuk Knoll 13 • Flemish Pass/Eastern Canyon 2
VME	• Beothuk Knoll • Southern Flemish Pass to Eastern Canyons • Flemish Cap East • Northern Flemish Cap • Deep Water Coral Area
*Overlapping of well event is based on the 95 percent ecological threshold for water column concentrations	

There was no predicted shoreline contact with hydrocarbons for this scenario.

With spill prevention plans and response procedures in place, potential effects of a subsurface blowout from the EL 1150 example well site on special areas are predicted to be adverse, medium in magnitude, medium to long-term in duration, occurring within the RSA and reversible. This was determined with a moderate level of confidence.

Figure 16.25 Model Results (Water Column Oil Concentration; Ecological Threshold) for Modelled Uncontrolled Well Event at EL 1144 Example Well Site in Relation to Special Areas

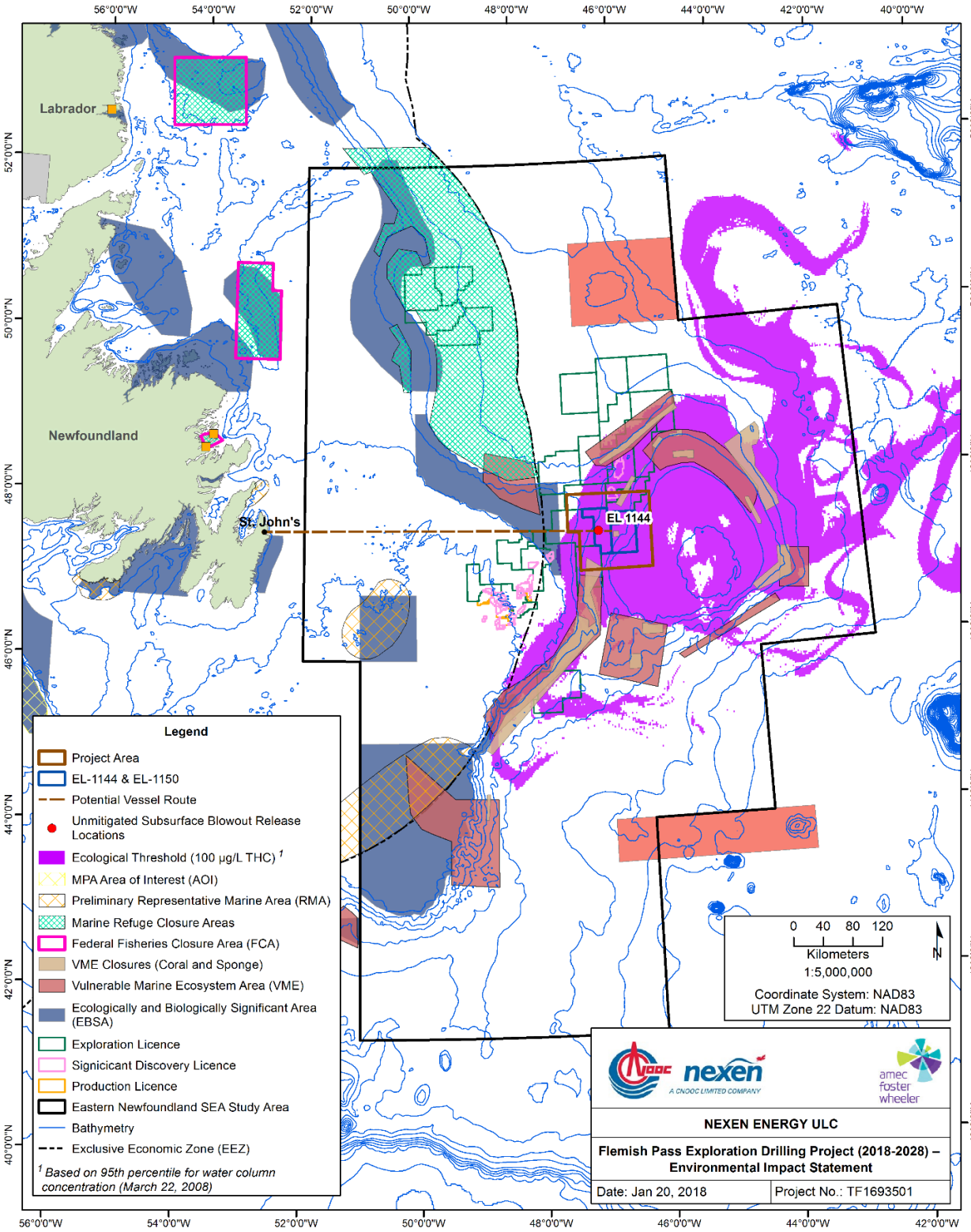
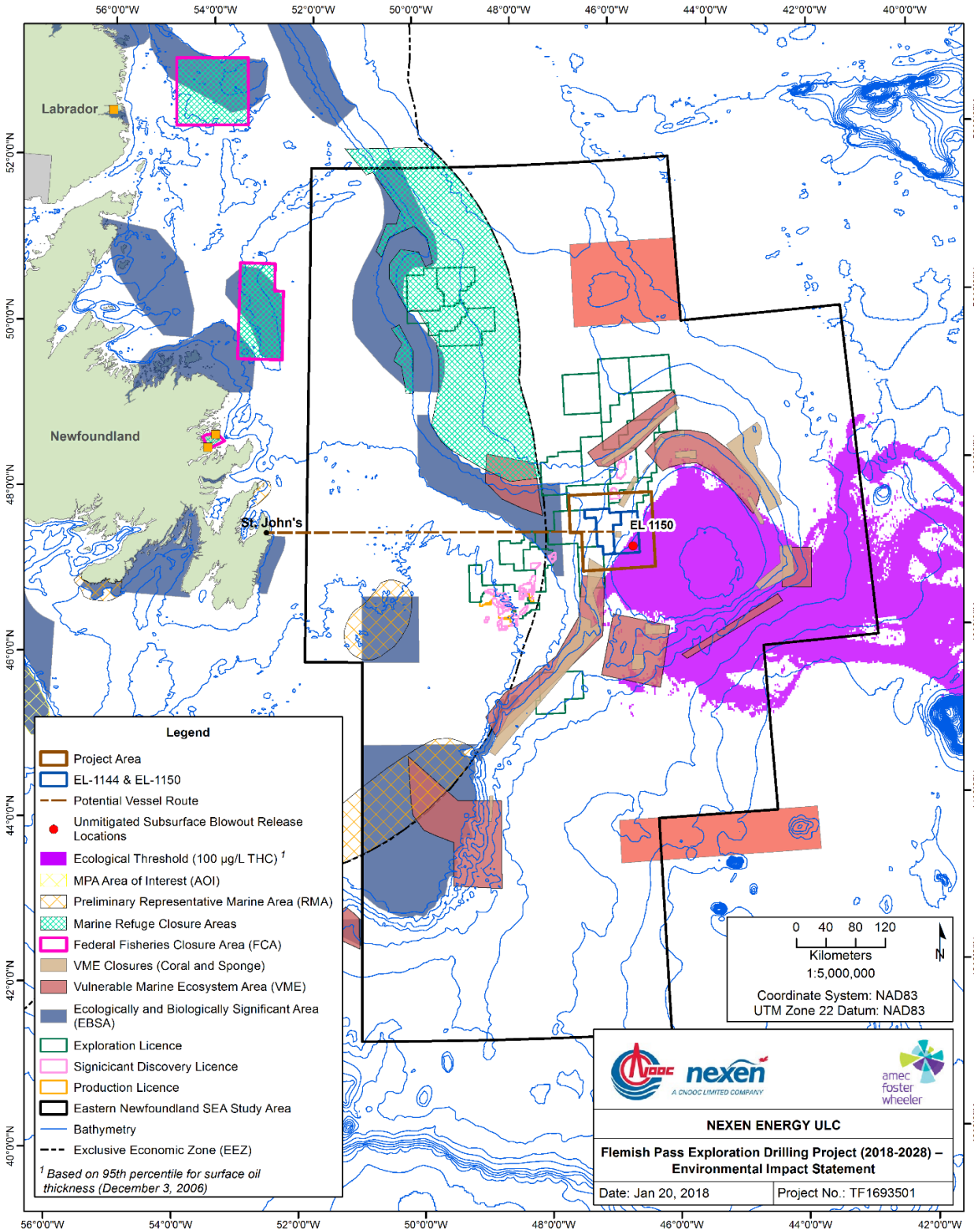


Figure 16.26 Model Results (Water Column Oil Concentration; Ecological Threshold) for Modelled Uncontrolled Well Event at EL 1150 Example Well Site in Relation to Special Areas



16.6.5.3 Summary and Determination of Significance

Table 16.22 provides a summary of predicted residual environmental effects of accidental event scenarios on special areas. Residual effects incorporate the conservative approach that was used for the spill modelling and the implementation of mitigation measures to prevent and reduce effects from a spill.

An accidental event such as a large diesel spill or a blowout would be prevented through the application of mitigation measures in Project planning and implementation, and reinforced through the various post-EA regulatory review processes and requirements that will apply to the proposed drilling activities that comprise this Project. The probability of such an accidental event occurring, and therefore resulting in adverse effects on this VC or any other component of the environment, is therefore very low. This is further reinforced through the oil spill probability analysis summarized earlier in Section 16.3, and presented in detail in the associated report included in Appendix F.

Large diesel spills from Project-related MODUs or vessels are both unlikely to occur, and in the event that one were to occur, would be unlikely to have detectable, adverse effects on any special areas. If any such interactions and associated effects did occur, these would be of limited magnitude, extent and duration, and addressed through the various response procedures outlined previously, which will further serve to prevent any adverse consequences for this VC.

A blowout event is a unlikely occurrence, especially with the various prevention measures that are required and committed to as outlined in this EIS. The modelling carried out for this EIS predicted limited potential interaction with the identified special areas in the offshore environment of Eastern Newfoundland. With the various spill response procedures outlined previously, it is considered unlikely that any of these special areas would be subject to oiling to the degree and duration that would result in a change in their overall, important and defining ecological and socio-cultural characteristics, resulting in a decrease in its overall integrity, value or use. In the unlikely instance that an accidental event such as a blowout did occur, the (conservative, without mitigation) oil spill modelling also predicts a very low probability of oil moving west and thus reaching the shoreline of Eastern Newfoundland and other areas of Atlantic Canada and any special areas within these regions.

Table 16.22 Summary of Residual Accidental Event-Related Environmental Effects on Special Areas

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: • Change in environmental features and/or processes • Change in human use and /or societal value							
100 litre Diesel Spill	A	N-L	L-PA	S	N-O	R	H
1,000 litre Diesel Spill	A	L-M	L-PA	M	N	R	M
750,000 litre Diesel Spill	A	L-M	L-RSA	M	N	R	M
Drill Fluid (SBM) Spill	N	-	-	-	-	-	H

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Subsurface Blowout – EL 1144 Example Well Site	A	M	RSA	M-L	N	R	M
Subsurface Blowout – EL 1150 Well Site	A	M	RSA	M-L	N	R	M

KEY

Nature / Direction:
- P Positive
- A Adverse
- N Neutral (or No Effect)

Magnitude:
- N Negligible
- L Low
- M Medium
- H High

Geographic Extent:
- L Localized
- PA Within Project Area
- LSA Within LSA
- RSA Within RSA or Beyond

Frequency:
- N Not likely to occur
- O Occurs once
- S Occurs sporadically
- R Occurs on a regular basis
- C Occurs continuously

Duration:
- S Short term
- M Medium term
- L Long term
- P Permanent

Reversibility:
- R Reversible
- I Irreversible

Certainty in Predictions:
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence
- N/A Not Applicable

In consideration of the present knowledge of special areas within the RSA, the result of spill modelling exercises, and potential mitigation, the predicted residual environmental effects from an accidental event scenario on special areas is considered not significant.

In the unlikely event of an offshore oil release, some degree of residual adverse effects to special areas that are within or near the zone of influence of the spill may be expected. The degree of exposure and thus the type and level of any such effects would depend on the type and size of spill, time of year, the location relative to special areas and other factors. Although there is the potential for effects on these areas and their associated environmental features and processes these are, with appropriate mitigations, not likely to result in an overall, adverse change in one or more of the important and defining ecological and socio-cultural characteristics of such an area, resulting in a decrease in its integrity, value or use over the long term. Spill prevention techniques and response measures will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further ensure that effects do not occur. Thus, in the unlikely instance that such an event did occur, it would not have significant adverse effects to nearby special areas.

16.6.6 Indigenous Peoples

As described in Sections 7.4 and 12.0 of this EIS, a number of Indigenous groups reside in Eastern Canada, including communities in Newfoundland and Labrador, the Maritime Provinces and Quebec. Although the environmental effects assessment for the Project's planned components and activities (Chapter 12) has predicted no adverse effects upon Indigenous groups, there is concern about the potential for an accidental event such as an oil spill to adversely affect Indigenous peoples in Eastern Canada. Questions and concerns about the occurrence, and potential effects, of such an accidental event were referenced by a number of Indigenous communities or their representative organizations during Nexen's EIS engagement program (Section 3.3). An accidental event could have adverse effects on Indigenous peoples, including effects on fisheries resources and/or fishing activity as well as the various socio-cultural components and activities specified in Section 5(1)(c) of CEAA 2012. The potential for, and nature and degree of, any such effects depends largely on whether and how the spill trajectory and the various components of this VC overlap in space and time.

16.6.6.1 Potential Issues and Interactions

The potential environmental effects on Indigenous peoples identified and used in the earlier environmental effects assessment for planned Project activities (Chapter 12) include the following:

- Change in health and socio-economic conditions
- Change in the current use of lands and resources for traditional purposes
- Change in physical and cultural heritage; and
- Change in any structure, site or thing that is of historical, archaeological, paleontological or architectural significance

These potential effects remain relevant to the assessment of accidental events. The effects of offshore oil and gas activities, including accidental events, on Indigenous peoples may be direct or indirect in nature. They may, for example, result from accidental events such as oil spills extending to and interacting directly with locations and environmental components that are used or otherwise valued by Indigenous people, including their communities, asserted or established traditional territories and resources, and other components of the health (physical or social), heritage (physical or cultural) and other socioeconomic conditions of an Indigenous group. Indirectly, any biophysical effects resulting from an accidental event such an oil spill on marine fish, birds, marine and migratory birds, and marine mammals and sea turtles that are used for traditional purposes can affect the physical health of persons who encounter these, through either direct exposure with the contaminants or through consumption of affected fish and wildlife (see Section 16.6.7.1 for a discussion of potential effects related to tainting). These biophysical effects may also have consequences for the availability or quality of the water, air, vegetation, fish or wildlife used by Indigenous peoples, thereby affecting the current use of these resources for traditional purposes, and in turn, the overall quality of life and well-being of a community. The Indigenous peoples VC is therefore closely linked to the other VCs considered in this assessment, particularly the biological VCs which have been assessed earlier, and for which significant adverse effects are not likely to occur.

This section assesses and evaluates the potential effects of potential accidental events on Indigenous peoples, including the various socio-cultural components and activities specified in Section 5(1)(c) of CEAA 2012.

Fish Species Used by Indigenous Groups

As described in Section 3.3 and 12.0, a number of individual fish species have been identified through Nexen's EIS engagement program as being used for traditional purposes by various Indigenous groups. Therefore, some additional information related to the potential effects of an oil spill on these species is provided here.

In terms of Atlantic salmon, as stated in Section 8.4.4, post-smolt and adult salmon are concentrated throughout the year in the Labrador Sea where they feed and overwinter. In the spring, both grilse and MSW adults appear to congregate in two general locations; near the eastern slope of the Grand Banks of Newfoundland and approximately 480 km east of the Strait of Belle Isle (Reddin and Friedland 1993; Reddin 2006) prior to their spawning migrations back to their natal rivers. Also noted earlier, smolt ages indicate that salmon congregating off the east Grand Banks area are likely from more southern populations from South Newfoundland, a portion of the Gulf of St. Lawrence, as well as Eastern – Southern Nova Scotia and Outer Bay of Fundy. While post-smolt do not likely overwinter in the Flemish Pass area (Reddin and Friedland 1993; Reddin 2006), migration as adults to the east Grand Banks area must occur. Although the exact migration route is not known, it may include areas within and near the Project Area, particularly during time periods when sea-surface temperatures are favourable (over 4°C).

The effects of oil associated with an accidental event on marine fish, including salmon, have principally been described using laboratory studies with farm raised fish or caged fish that are unable to avoid oil exposure (e.g., Barnett and Toews 1977; Thomas and Rice 1987; Fraser 1992; Pineiro et al 1996; Zhou et al 1997; Stagg et al 1998; Meador et al 2006; Stieglitz et al 2016). Many of these studies showed effects on feeding, food conversion, or changes in enzyme levels based on exposure; however, returns to baseline were generally noted in 2-8 weeks (Fraser 1992; Stagg et al 1998). It is noteworthy that many of the concentrations used in lab studies were high compared to the results of subsurface blowout modelling described above. For example, Stagg et al (1998) investigated the effects of the Braer oil spill on the Shetland Isles, Scotland. They characterized reference sites in the north of Shetland as having oil in water concentrations between 2 and 5 µg/L and regarded these as being typical background values for the local inshore environment. No effects on farmed salmon enzyme and protein levels were detected at these concentrations. Barnett and Toews (1977) observed no mortality in post-smolt Atlantic salmon during 96-hour acute lethal bioassays with concentrations up to 32 mg/L.

Few studies have been conducted on the avoidance behaviour of returning adult salmon to hydrocarbons in water under natural conditions. Weber et al (1981) conducted a behavioural study on adult Pacific salmon (*Oncorhynchus sp*.) where hydrocarbons that closely approximated the water-soluble fraction of Prudhoe Bay crude oil were added in one of two fishways as salmon were migrating upriver. They found that migrating salmon substantially avoided (i.e., when 50 percent of fish which were expected to ascend a fishway avoided it) hydrocarbons in the water at concentrations of 3,200 µg/L. Concentrations used in the study ranged from 300 to 6,100 µg/L.

American eel are occasionally present in the RSA as adults migrate from coastal areas to the Sargasso Sea (Scott and Scott 1988). Migrations of adults and larvae generally follow continental shelf areas (Wang and Tzeng 1998), reducing likelihood of passing through any potentially affected area. Like other fish, oil exposure has been shown to induce oil degrading enzymes like CYP1A (Schlezinger and Stegeman 2000) with a 5 mg/kg dose response, a sensitivity that is less than that of other fish. It has

been speculated that this is due to the species' life history, as they spend a portion of their life in estuaries where they have increased chance of exposure to contaminants and therefore less sensitivity (Schlezinger and Stegeman 2000).

The RSA is within the overall areas used by swordfish, whose overall distribution and migration patterns include most of the North Atlantic Basin (Dewar et al 2011, Trenkel et al 2014). Swordfish numbers and their overall ranges and migration patterns (Section 6.1.7) therefore make it unlikely that they would be present within the affected area during an accidental event, and the highly mobile nature of this species would likely allow individuals to avoid affected areas.

Detailed assessments and evaluations of the potential environmental effects of a Project-related accidental event on marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles, were provided in the preceding sections.

16.6.6.2 Environmental Effects Assessment

The potential environmental effects of an accidental hydrocarbon release on the various components of this VC are assessed in the following subsections.

Marine Diesel Spills (Batch Spills and Vessel Collision Scenario)

A potential batch spill from a Project-related MODU or supply vessel, although an undesirable and environmentally important occurrence, would be limited in terms of its overall magnitude, extent and duration, and thus, its potential environmental consequences.

The geographic extent of such Project-related accidental discharges and their effects, if they did occur, would therefore be localized to the Project Area or elsewhere in the offshore marine environment several hundred kilometers from the Island of Newfoundland, and thus at considerable distance from any Indigenous communities or their known activities or other interests (Section 7.4). No direct effects on Indigenous peoples are therefore predicted to occur as a result of such an accidental event. Moreover, given the distances involved, they would not interact with nor adversely affect the physical and cultural heritage of any Indigenous group. The Project Area and RSA are not known to contain resources of historical, archaeological, paleontological, or architectural significance, and given their location far offshore Eastern Newfoundland, are not likely to contain such resources or materials that are relevant to and valued by any Indigenous group.

As discussed and illustrated in Section 7.4, there are no known Indigenous groups that hold, claim or assert Aboriginal or Treaty rights or otherwise undertake traditional activities within or near the Project Area, and thus, within the environmental zone of influence of any such batch spills. Although fishing enterprises associated with several of these organizations undertake commercial fishing activity within NAFO Divisions that overlap parts of the Project Area (Section 7.2), it is understood that these organizations undertake fishing activities off Eastern Newfoundland and these contemporary, commercial land and resource use activities may not be considered traditional in that they are not a continuation of ancestral activities that took place historically within this area offshore Eastern Newfoundland. The potential effects of the Project on commercial fishing activities by Indigenous groups are addressed as part of the Fisheries and Other Ocean Uses VC (Section 16.6.7).

Although there is the potential for indirect effects to Indigenous groups through associated effects on migratory marine species (fish, birds, or mammals) moving through the affected area, given the small and localized nature of a batch spill no adverse effects are anticipated. As described earlier in this chapter for the various preceding biophysical VCs, any such batch spill events, if they did occur, are not expected to result in any significant adverse effects upon marine fish, birds, or mammals (including those known to be or potentially used for traditional purposes), and the various environmental mitigation initiatives identified and proposed throughout this EIS will help avoid or reduce any associated effects on these species. There is therefore almost no potential for the biophysical effects of the Project to have an adverse effect on the presence, abundance, distribution or quality such resources in any area, and especially, on their overall availability for resource use activities by Indigenous groups within their traditional harvesting areas. There will therefore be no potential for any such biophysical effects (should they occur) to translate into any decrease in the overall nature, intensity, distribution (location or timing), quality or cultural value of these traditional activities by any Indigenous group. Similarly, any such effects are unlikely to extend to or affect the physical (through, for example, ingestion of toxic materials) or social health and well-being of any Indigenous persons or communities.

With spill prevention plans and response procedures in place, there is a very low probability of a large spill event occurring. In the event that such a spill did occur, it is not likely to directly interact with or adversely affect Indigenous peoples, nor to have effects on marine-associated resources used by these groups in a manner or to a degree that would affect their availability, quality or use.

Adverse effects of a diesel spill on Indigenous peoples are therefore not anticipated. This was determined with a moderate to high level of confidence.

Drill Fluid (SBM) Spill

The relevant drill fluid model results are summarized in Section 16.5. An SBM spill would have the potential to result in seabed disturbance, chemical toxicity, and bioaccumulation (uptake of contaminants by fish and the presence or perception of taint). As discussed in detail in Chapter 8, the acute toxicity of SBMs is considered relatively low and below environmental guidelines and therefore will not result in adverse effects from contamination of marine biota or habitats. An authorized discharge of spent SBMs (i.e., mix of SBM and cutting) would be similar in terms of extent and duration to the effects of drill fluid cuttings during normal operations, where a localized increase in total suspended solids would be expected. Adverse effects of a drill fluid spill on Indigenous peoples are therefore not anticipated. This was determined with a high level of confidence.

Uncontrolled Well Event

The relevant model results for uncontrolled well events are summarized in Section 16.4. Given the potentially large amount of discharged oil that could conceivably be associated with such a blowout event, and the possibility for such a spill to extend to areas beyond the well site and Project Area, a well blowout represents the accidental event with the most potential to affect Indigenous peoples in Newfoundland and Labrador and elsewhere in the larger Eastern Canada region.

Notwithstanding the much larger size and magnitude of such a blowout as compared to a smaller batch spill during routine operations, most of the potential issues, key considerations and general principles associated with the potential effects of a batch spill on this VC, as described above, are also relevant

here. Specifically, the potential for direct interaction between the oil spilled during a potential blowout event and any Indigenous group and its activities (such as hunting and fishing) are extremely low, given the overall distances between the Project Area and any such Indigenous community (at least 635 km), and the lack of known traditional activities that occur in the surrounding region. Of particular interest, however, is the potential for such an oil spill in the marine environment to spread to and directly affect Indigenous groups and their activities elsewhere in Eastern Canada.

As described below, while the oil spill modelling indicates a potentially large area being affected in the event of an unmitigated event, many of the areas delineated have very low probabilities of being affected, and in an actual incident, appropriate spill response measures will be implemented to help reduce the magnitude, duration and geographic extent of the spill and thus its environmental effects.

EL 1144 Example Well Site

As described in the preceding analysis, for each of the modelled releases, oil on the surface was most likely to move to the east due to the prevailing westerly winds and surface currents within the region. There is therefore very little potential for any such spill to reach and adversely affect any communities in Eastern Newfoundland or elsewhere in Eastern Canada. It is thus unlikely to result in any effects on any Indigenous group or its activities or other interests, including physical and cultural heritage or any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance.

In terms of potential indirect effects due to associated biophysical changes resulting from such a spill, while it is not possible to determine with certainty whether a migratory individual of any species used for traditional purposes by any group may be present in the affected area before moving to an area that is the subject of traditional harvesting activity, as illustrated in Chapter 12 there is limited potential for any degree of interaction. The probability of a spill occurring is extremely low, and in the event of a spill, the species (individual fish, bird or marine mammal) would have to be present in the area at that time to be potentially affected. As described for the various preceding biophysical VCs any such accidental events are, with appropriate mitigation in place, not expected to result in any significant adverse effects upon marine fish, birds, or mammals. There is therefore little potential for any effects on marine-associated species in general (and individuals in particular) to translate into a detectable effect on the use of such species for traditional purposes by an Indigenous group in Eastern Canada.

With regards to Atlantic salmon in particular, based on laboratory experiments it is unlikely that concentrations comparable to laboratory-observed effects would be present during an accidental event beyond the immediate Project Area. In situ experiments indicate that salmon in natural conditions (not in a lab or a cage) can likely detect hydrocarbons at concentrations approximately ten percent of those shown to cause mortality and avoid them. As shown in the accidental release modelling, predicted concentrations will generally be lower than those shown to cause avoidance in salmon and spill trajectories are in a predominantly eastern and south-eastern direction. If an accidental release occurred during the spring migration and/or congregation of returning Atlantic salmon to the east of the Grand Banks, concentrations near the release area, particularly the EL 1144 example well site, could have concentrations (500 or greater µg/L) of dissolved hydrocarbons in the water column that salmon have been shown to avoid. However, given the predicted extent of these concentrations, it is unlikely that migration and behaviour would be affected to the extent that they would not be capable of navigating to their home river.

For all species, as noted throughout, the probability of such a spill occurring is extremely low, and in the event of a spill, the resources in question, would have to be present in the area at that time to be potentially affected.

With spill prevention plans and response procedures in place, any adverse effects of a subsurface blowout from the EL 1144 example well site on Indigenous peoples (if they did occur) are predicted to be adverse, negligible to low in magnitude, medium to long-term in duration, occurring within the RSA, and being reversible in nature. This conclusion has been reached with a moderate level of confidence.

EL 1150 Example Well Site

Based on the unmitigated scenario, it is predicted that such a release of hydrocarbons into the marine environment is likely to move eastward due to the prevailing westerly winds, and thus away from any Indigenous communities and territories in Newfoundland and Labrador, the Maritime Provinces or Quebec. There was no predicted shoreline contact from the releases at the EL 1150 example well site. Such a spill is therefore unlikely to result in any effects on any community or its activities or other interests, including physical and cultural heritage or any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance.

In terms of potential indirect effects on such activities, the environmental effects assessment for this VC again considers whether and how Project-related changes in and effects on the biophysical environment within the potential zone of influence of such a spill may affect resources that are used for traditional purposes by Indigenous groups, including as a result of the known migration and movement patterns of marine-associated biota that are known to be used for these purposes. While it is again not possible to determine with absolute certainty whether any particular individual of any species (in any life history stage) used for traditional purposes by any group may be present in the affected area before moving to an area that is the subject of traditional harvesting activity, as illustrated in Chapter 12 there is limited potential for any degree of connection. As also described for the various preceding biophysical VCs any such accidental events are, with appropriate mitigation in place, not expected to result in any significant adverse effects upon marine fish, birds, or mammals (including those used for traditional purposes). There is therefore little potential for any effects on marine-associated species in general (and individuals in particular) to translate into a detectable effect on the use of such species for traditional purposes by an Indigenous group elsewhere in Eastern Canada. Adverse effects on the health of Indigenous peoples are also not predicted to occur as a result of the Project as a result of these factors, and given the imposition of a temporary harvesting closure around the affected area.

As noted throughout, the probability of such a spill occurring is extremely low, and with spill prevention plans and response procedures in place, the potential effects of a subsurface blowout from the EL 1150 example well site on Indigenous peoples are predicted to be adverse, negligible low in magnitude, medium to long-term in duration, occurring within the RSA, and reversible in nature. This conclusion has been reached with a moderate level of confidence.

16.6.6.3 Summary and Determination of Significance

Table 16.23 provides a summary of predicted residual environmental effects of the various accidental event scenarios on Indigenous peoples.

An accidental event such as a large diesel spill or a blowout will be prevented through the application of mitigations measures in Project planning and implementation by the Nexen, and reinforced through the various post-EA regulatory review processes and requirements that will apply to the proposed drilling activities that comprise this Project. The probability of such an accidental event occurring, and therefore resulting in adverse effects on this VC or any other component of the environment, is therefore very low. This is further reinforced through the oil spill probability analysis summarized earlier in Section 16.3, and presented in detail in the associated report included in Appendix F.

Large diesel spills from Project related MODUs or vessels are both unlikely to occur, and in the event that one were to occur, the relatively localized and short term nature of any resulting environmental disturbance and associated effects, coupled with the lack of Indigenous communities and activities in this offshore area, would mean that there is little or no potential for adverse effects on the various components of this VC. These would be responded to through the various response procedures outlined previously, which will further serve to prevent any adverse effects from occurring.

A blowout event is unlikely to occur, especially with the various prevention measures that are required and committed to in this EIS. In the unlikely event that an accidental event such as a blowout did occur, the (conservative, without mitigation) oil spill modelling carried out for this EIS predicts a very low probability of oil moving west and thus reaching the shoreline of Eastern Newfoundland and other areas of Atlantic Canada, and thus, coming into direct contact with any Indigenous communities or activities. As described for the various preceding biophysical VCs, any such event is also not expected to result in significant adverse residual effects upon marine fish, birds, or mammals, and would thus not have a significant effect on the presence, abundance, distribution or quality such resources in the area, and thus, their availability for resource use activities by these groups within their traditional harvesting areas. In particular, there would be no potential for such direct and/or indirect biophysical effects to translate into any decrease in the overall nature, intensity, distribution, quality or cultural value of these traditional activities by Indigenous peoples.

Any accidental events that may be associated with the Project are therefore not likely to result in significant adverse environmental effects on Indigenous peoples.

Table 16.23 Summary of Residual Accidental Event-Related Environmental Effects on Indigenous Peoples

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: • Changes in health and socioeconomic conditions; • Changes in the current use of lands and resources for traditional purposes; • Changes in physical and cultural heritage; and • Changes in any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance.							
100 litre Diesel Spill	N	-	-	-	-	-	H
1,000 litre Diesel Spill	N	-	-	-	-	-	H
750,000 Diesel Spill	N	-	-	-	-	-	M

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Drill Fluid (SBM) Spill	N	-	-	-	-	-	H
Subsurface Blowout – EL 1144 Example Well Site	A	N-L	RSA	M-L	N	R	M
Subsurface Blowout – EL 1150 Example Well Site	A	N-L	RSA	M-L	N	R	M

KEY

Nature / Direction:
- P Positive
- A Adverse
- N Neutral (or No Effect)

Magnitude:
- N Negligible
- L Low
- M Medium
- H High

Geographic Extent:
- L Localized
- PA Within Project Area
- LSA Within LSA
- RSA Within RSA or Beyond

Frequency:
- N Not likely to occur
- O Occurs once
- S Occurs sporadically
- R Occurs on a regular basis
- C Occurs continuously

Duration:
- S Short term
- M Medium term
- L Long term
- P Permanent

Reversibility:
- R Reversible
- I Irreversible

Certainty in Predictions:
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence
- N/A Not Applicable

16.6.7 Fisheries and Other Ocean Uses

Sections 7.2 to 7.3 describe the relevant and socially and economically important marine activities that occur in and near the Project Area and RSA, as well as the fisheries management and regulatory regimes within Canada's EEZ and the NAFO Regulatory Area. The current commercial domestic fisheries in the general area, including Indigenous commercial licences, consist primarily of snow crab harvesting, using fixed gear, and some groundfishing (mainly turbot/Greenland halibut and redfish using mobile and fixed gears), while foreign fishing beyond the EEZ is directed primarily towards groundfish. Northern shrimp had been a key species for both domestic and foreign harvesters before recent conservation-based closures. Fisheries research programs (industry and government sponsored) also occur on and near the eastern Grand Banks, while other fisheries activities (seal harvesting, recreational fishing, aquaculture) are focused closer to shore and outside the Project Area and surrounding areas. No known Indigenous food, social, or ceremonial fishing takes place within or near the Project Area.

Fisheries in the broader RSA (described in Section 7.2) are similar in the offshore areas, but include a greater mix of species and harvesting methods closer to shore. As with the Project Area fisheries, NAFO 3KLMNO domestic commercial harvests have been predominantly shellfish, mainly snow crab and Northern shrimp (which is still permitted in 3K), but with an important component of lobster and some

other shellfish harvests (e.g. sea urchins) from the coastal waters of 3K and 3L. Groundfish and pelagic species harvests are also more diverse throughout the RSA, and deep-sea clams are a very important commercial species in offshore areas south and south-west of the Project Area, in 3N and 3L. Aquaculture facilities are located at various sites around the Newfoundland coast, particularly within Notre Dame Bay, in NAFO 3K. Seal harvesting, recreational fisheries and science research surveys are also expected to occur within 3KLMNO, as described in Section 7.2. As in the Project Area, some of these fisheries may take place year-round, though most marine activities are concentrated in the spring and summer months.

Other human uses of the marine environment in the region are also important for their economic and/or socio-cultural value. As described in Section 7.3, other components and activities that do or may occur within or near the Project Area and RSA and are considered as components of this VC include general marine shipping, other oil and gas related activities (such as seismic exploration, production platforms and associated marine traffic and support vessels), military operations (such as surveillance, monitoring, training, rescue), other submarine infrastructure (such as communication cables) and the possible presence of UXO.

16.6.7.1 Potential Issues and Interactions

Most of the potential environmental interactions and resulting effects on fisheries and other ocean uses associated with planned, routine activities and identified for the purposes of the assessment in Chapter 13 are also relevant for potential accidental events. These include:

Fisheries

- Temporary lost or reduced/delayed access to commercial species (from interference, excluded fishing grounds, decreased harvesting efficiency, or species availability, abundance, and distribution) by fishers and science surveys
- Increased expenses associated with fishing more distant grounds, detours to avoid affected areas, and reduced availability of affected fishing gear
- Costs to repair or replace damaged fishing gear, facilities or vessels caused by spilled hydrocarbons or debris
- Actual or perceived quality of fisheries resources and resulting market/price effects

Other Ocean Uses

- Direct contact with and damage to in situ component of spill and/or debris
- Interference with other marine activities

In the case of an accidental event such as a batch spill or a blowout, the potential for negative interactions with fish harvesting and other ocean uses is likely to be greater than from planned activities, although the actual effects from any such event will depend on the interaction of several factors such as the quantity and type of hydrocarbons released, the specific location of the release, the time of year (in particular, what fisheries and other activities are occurring then), the prevailing environmental conditions at the time, the duration of the hydrocarbon release, the location of hydrocarbons in the water column, the effectiveness of clean-up or other response actions and, overall, the fate of the released substance. These conditions will determine the severity of the effects of a spill, and the type and extent of any effects on fisheries. Other ocean uses (particularly any activities at or near the ocean surface)

could also be impeded by the presence of an oil slick and clean-up activities, which would have to be avoided while present.

Existing Knowledge of the Effects of Hydrocarbons on Fisheries and Other Ocean Uses

The abundance, distribution, and quality of commercial marine species in a given area might be negatively affected because of direct biological effects from the presence of spilled hydrocarbons in the water, or indirectly through biological effects on prey species and habitat, which could in turn affect the availability and quality (condition of fish, tainting) of the resources that are able to be accessed by commercial harvesters. The assessment of potential biophysical effects on marine fish and fish habitat that might result from hydrocarbon spills (including from clean-up methods, such as the application of dispersants) are addressed in Section 16.6.2 and those effects related to commercial species are not addressed again here in any detail. Consequently, this section focuses more specifically on potential effects on harvesting opportunities and related economic returns, and on similar potential effects on other ocean uses.

Interference with commercial fishing would occur if active fishing areas are closed because of a spill, either by way of a regulatory decision or as a defacto closure because of hydrocarbons in the water. Alternatively, a spill may prolong the duration of an previously closed fishery that is closed due to other reasons. Interference might include the need to avoid an oil slick, to change grounds (if available under the relevant licence conditions) or stop fishing for other reasons (e.g. as a precaution to prevent a potentially tainted product from entering the marketplace). Even if benthic species were not affected by surface hydrocarbons, hauling these catches through oily waters would could cause some concern in terms of potential or perception of taint. For commercial harvesters, such interferences could translate into direct economic effects as fishers delay or cease fishing activity until the area has been re-opened, or move to other available but more distant fishing grounds, curtailing harvesting opportunities and increasing costs. For example, after the Gulf of Mexico DWH spill in 2010, short-term marine closures affected approximately 207,200 km² (80,000 square miles) of the US EEZ (DFO 2013). The magnitude of these effects in Newfoundland and Labrador waters would depend on such factors as the size of area closed to commercial fishing, the time of year, and the length of the closure time. Similarly, opportunities for, and the quality of, routine marine science research could be affected through closures, fouled equipment, or contaminated results because of hydrocarbons on surface water or in the water column. Offshore exercises such as military training could also be compromised by the presence of a spill, as could the activities of other ocean uses if impeded in their operations or in their use of regular transit routes.

Damage to fishing vessels and gear could result from contact with the spilled oil, which might affect the efficiency of harvesting, or cause them to stop fishing, resulting in extra costs (replacing, cleaning or repairing gear) and consequent lost income (IPIECA 1997).

As noted, spills can also affect consumer perceptions of, and confidence in, product quality, which may affect the price paid to harvesters and within the consumer marketplace (ITOPF 2004, 2011; IPIECA 1997), or might close markets altogether, for a time, if catches are tainted or otherwise unfit (IPIECA 1997; Amec 2014).Tainting occurs when fish species are exposed to hydrocarbons and absorb oil-derived substances into their tissues, which can cause unpleasant odours and flavours until lost through the normal metabolic processes. Both chemical analysis and organoleptic testing are usually conducted before a species is declared safe to consume or re-introduce into the marketplace. Even if an oil spill

does not reach particular commercial fishing grounds and fish species are determined not to be tainted, publicity related to accidental events can affect consumer perceptions of fish harvested even in areas beyond the area physically affected, potentially reducing the value of a product because of real or perceived public health concerns. Market confidence, consumer behaviour, and resulting effects based on perceptions of products are difficult to predict, and may only be measured after an event occurs (ITOPF 2011).

Although there are no aquaculture operations near the Project Area, if a spill were to reach the shoreline, effects on these operations could also occur (e.g., biophysical effects, gear and vessel fouling, actual and/or public perception of taint). This would result in similar economic effects on aquaculture as on inshore commercial fisheries, with the exception that, unlike wild fisheries, there is no possibility to relocate business activities away from an affected area. Seal fishing and recreational fishing activities might be similarly restricted in affected areas until remediation is sufficiently complete.

Existing Knowledge of the Effects of Dispersants on Fisheries and Other Ocean Uses

As described and assessed in Section 16.6.2 chemical dispersants that might be used to mitigate or manage spills also have the potential to affect fish and fish habitat, and therefore have a potential to indirectly affect commercial fisheries through tainting and/or market perceptions with the similar consequences as from hydrocarbon spills. Indirect effects from the use of dispersants can also affect other ocean uses such as fisheries scientists if targeted species are involved and the ability to make management decisions is therefore compromised. However, as also discussed in Section 16.6.2, DWH studies of commonly used dispersant on key species found little to no bioaccumulation and rapid depuration (24 to 72 hours; Tjeerdema et al 2013). As with the presence of spilled hydrocarbons, the presence of spill cleanup and activities and remediation operations could also interfere with or limit fishing opportunities while they are present in fishing areas. Other ocean uses might be similarly hindered by clean-up if impeded in their operations or their use efficient transit routes.

Existing Knowledge of the Effects of Drill Fluids (SBMs) on Fisheries and Other Uses

The effects of an accidental spill of drill fluids on fisheries and other uses would be similar in nature to a small batch spill (as described above). SBMs, however, are a heavy, dense fluid which sinks rapidly so the effects on the water's surface would be limited as it sinks through the water column. Therefore, harvesting opportunities would not be affected and the main concern would likely be the perception of taint.

16.6.7.2 Environmental Effects Assessment

In addition to the accidental events mitigation and response measures detailed in Section 16.1, and specific to this VC, Nexen will develop and implement a compensation program for any economic damages suffered by fish harvesters caused by any unauthorized discharge, emission or escape of petroleum, or the escape of debris. This program will serve as a means of mitigation for any residual economic effects on the fisheries that could not be prevented or fully mitigated by other measures. It will be developed to resolve claims in an efficient and timely manner, in consideration of relevant best practices, precedents and industry guidelines, and in accord with the C-NLOPB's Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (2017).

This program will outline compensation procedures for actual loss or damages to commercial fishers, including loss of income, future loss of income, and costs and expenses incurred for action taken to remedy a situation involving a spill, such as measures to control or clean spilled hydrocarbons from gear and equipment. Requirements from the C-NLOPB include the ability of an operator to demonstrate the financial resources to meet a liability obligation of CAD $1 billion relating to damages, and to pay a deposit of $100 million for financial responsibility in case an accidental event might occur. One Ocean is currently developing a best practices document related to petroleum industry compensation in Newfoundland and Labrador waters, which aims to provide additional details and information to assist with processes and procedures for applying and receiving compensation in the event of an incident. Notices to Shipping / Mariners related to an accidental event will provide contact information for compensation claims, as well as for information about response activities in the event of a spill.

As noted above, compensation planning for accidental fishing gear and/or vessel damage occurring as a result of planned operations is described in Section 16.6.7.3.

Marine Diesel Spills (Batch Spills and Vessel Collision Scenario)

The relevant spill results for diesel spills (100 L, 1,000 L, 750, 000L) are summarized in Section 16.4. As indicated, the predicted area where any spilled diesel may spread overlaps with active commercial fishing grounds. In the event of a batch spill, there is potential for temporary closure of commercial fish harvesting in the immediate area due to the potential of gear fouling; however, it is expected that this closure would be short-term. Due to the oceanic conditions and expected quick weathering of any such spilled materials, and the ability of mobile adult fish species to either avoid the spill or metabolize and depurate hydrocarbons, it is expected that this interaction would also be limited to the immediate area of the spill, and short-term in duration.

It is anticipated that with the implementation of mitigation measures, the geographic extent and concentration of a spill would therefore be limited. A change in the distribution or quality of marine resources, including commercial fish species, is considered unlikely, given that the oceanic conditions and mitigation measures would likely result in the spill being contained to a smaller area and for a shorter period of time.

With spill prevention plans and response procedures in place, including compensation plans, potential effects of a diesel spill (100 L 1,000 L, 750,000 L) on fisheries and other ocean uses are predicted to be adverse but negligible to low in magnitude, short to medium-term in duration, localized to occurring within the RSA (depending on spill size and location), and reversible. This was determined with a high level of confidence.

Drill Fluid (SBM) Spill

As discussed, SBMs are a heavy, dense fluid which sinks rapidly so the effects on the water's surface would be limited as it sinks through the water column. Therefore, harvesting opportunities would not be affected and the main concern therefore would be the perception of taint. The model predicts a limited footprint on the seafloor. With spill prevention plans and response procedures in place, potential effects of a drill fluid spill on fisheries and other ocean uses are predicted to be adverse, negligible in magnitude, short -term in duration, localized, and reversible. This was determined with a high level of confidence.

Uncontrolled Well Event

The relevant model results for uncontrolled well events are summarized in Section 16.4. The potential effects from an uncontrolled well event on fisheries and other ocean uses include direct effects resulting from potential fisheries closure areas and fouling of fishing gear, vessels and equipment and indirect effects related to the biophysical effects on fish species that may be targeted as part of a commercial fishery. Effects from an oil spill on fish and fish habitat, including the use of dispersants on an oil spill is assessed in Section 16.6.2. It is anticipated that most free-swimming mature fish species may be able to avoid exposure to oil in the water column; however, if oil managed to reach the seafloor, some slow moving or sessile organisms could be exposed to interactions with hydrocarbons. With the implementation of mitigation measures, it is not anticipated that there would be a long-term exposure of fish to hydrocarbons either at the surface or within the water column. The ability of some fish species to metabolize and depurate hydrocarbons also promotes a short-term interaction.

EL 1144 Example Well Site

The modelling shown in Figure 16.27 predicts that a hypothetical spill from the modelled EL 1144 example well site might have an oil surface thickness of >0.04 µm in some parts of NAFO Unit Areas 3Li, 3Lt and 3Nb beyond 200 NMi, but with the greater potential presence after 30 days being in NAFO Division 3M, primarily near and over the Flemish Cap. The main domestic commercial fisheries (Section 7.2) in these areas are for snow crab (within Crab Fishery Area (CFA) 3L200), near the EEZ boundary, and groundfish harvesting (including Atlantic cod, turbot/Greenland halibut, haddock and redfish), mainly on and around the Cap. Northern shrimp harvesting was also active in the region before it was closed in 2015, particularly around the Nose of the Grand Banks, as Section 7.2 indicates. Foreign fishing in the area (approximated by the NAFO Footprint outline, Figure 16.27) is now primarily for various groundfish species, mainly Atlantic redfishes, Atlantic cod and turbot/Greenland halibut (Section 7.2). As the data in Figure 16.27 indicate, the area immediately affected according to this modelling recorded relatively low domestic fishing intensity 2010-2015 compared to some other areas on the Grand Banks. There are no known recreational or non-commercial indigenous fisheries in the areas where there is a likelihood of the presence of surface oil based on this modelling.

As discussed above, this type of release could result in interactions with commercial fishing activities and with other ocean uses, including the implementation of fisheries closure areas, delay re-opening of already closed areas, and the fouling of gear and vessels and/or economic impacts in the marketplace. It is important to note that these models represent the worst-case scenario possible with no mitigation measures being implemented. The subsequent effects on commercial fishing and other ocean uses would depend on the volume of oil released, the time of year, and the implementation of mitigation and response measures. Although a temporary closure of one or more areas to fishing activities and other ocean use may result in the event of a subsurface blowout, the geographic and temporal extent would be reduced through the implementation of mitigation and response measures. In addition, the issuance of a Notices to Shipping, Notices to Mariners and Notices to Fish Harvesters as well as direct communications with fisheries interests and representatives will provide timely notice of closure areas, providing fishers opportunity to make alternative plans, thereby reducing effects on commercial harvesting activity to the extent feasible. In the event of gear fouling, the compensation program for damages would be activated, reimbursing the cost of damaged or lost fishing gear. Likewise, other commercial damages or losses associated with the spill would be addressed through a financial compensation program in accord with the C-NLOPB Compensation Guidelines. Fouling also has the

potential to affect other ocean uses, as equipment and vessels related to research and military training could be fouled, and result in adverse effects on those operations.

Oil that is predicted to make contact with the shoreline is expected to be highly weathered, patchy and discontinuous. Inshore operations such as aquaculture and commercial fishing, and recreational use of coastal waters, could be affected if surface oil from a blowout scenario reached the shoreline, modelled to be unlikely and only occurring after 52 days, at which time it would be highly weathered. The modelling results show that the locations where oil is predicted to make contact with the shoreline do not currently have aquaculture operations. Given the length of time required before making contact with the shore, and the condition of the oil when it would arrive at the shoreline, it is not expected that it would interact in a way that would produce adverse environmental effects with aquaculture operations. The implementation of mitigation measures by Nexen would further reduce the likelihood of shoreline contact, with compensation available if such contact were to occur and result in financial loss.

With spill prevention plans, response procedures and Nexen's required compensation program in place, potential effects of a subsurface blowout from the EL 1150 example well site on fisheries and other ocean uses are predicted to be adverse, low in magnitude, medium to long-term in duration, occurring within the RSA, and reversible. This was determined with a moderate level of confidence.

EL 1150 Example Well Site

A subsurface blowout at the example wellsite within EL 1150 as illustrated in Figure 16.28 could affect fishing activities within some parts of NAFO Unit Areas 3Ma, 3Li and 3Lt. According to this scenario, the areas potentially affected are outside Canada's EEZ and focused in relatively small areas over the western slope of the Flemish Cap and the Flemish Pass. The domestic fishing intensity mapping shown in Figure 16.28 indicates that the harvesting near the affected areas is on the low end of that spectrum. Based on these data, the only domestic species fishery occurring at the predicted surface oil locations for the scenario shown in Figure 16.28 is Atlantic cod. As noted above, foreign fishing in the general area is mainly for various groundfish species such as Atlantic redfishes, Atlantic cod and Greenland halibut/turbot, although shrimp harvesting had been important around the Flemish Cap before 2015. There are no known recreational or non-commercial indigenous fisheries in the areas where there is a likelihood of the presence of surface oil based on this modelling.

Possible interactions with fisheries and other ocean uses include those discussed above, including: fisheries closure areas, shipping closures or rerouting, the fouling of gear and/or vessels, and possible market effects. It is important to note that these models represent a very large blowout with no mitigation measures being implemented. Actual effects on commercial fishing and other ocean uses would depend on the volume of oil released, the time of year, and the implementation of mitigation and response measures. Although a temporary closure of one or more areas to fishing activities and other ocean use could result, the geographic and temporal extent would be reduced through the implementation of mitigation and response measures. The issuance Notices to Shipping, Notices to Mariners and Notices to Fish Harvesters as well as direct communications with fisheries interests and representatives will provide timely notice of closure areas, giving fishers opportunity to make alternative plans, thereby reducing effects on commercial harvesting activity and notifying fishers to avoid the area, and reducing potential gear/vessel fouling. In the event of gear fouling, the compensation program for damages would be activated, mitigating the cost of damaged or lost fishing gear. Likewise, other commercial damages or losses associated with the spill would be addressed through Nexen's required compensation

program. Fouling also has the potential to affect other ocean uses, as equipment and vessels related to research and military training could be fouled, and result in adverse effects on those operations. With the implementation of the compensation program and other mitigation measures, combined with the unlikely event of a blowout occurring, the potential for fisheries closures and fouling of vessels, gear, and equipment and associated economic losses is considered low.

With spill prevention plans, response procedures and the compensation program in place, potential effects of a subsurface blowout from the EL 1150 example well site on fisheries and other ocean uses are predicted to be adverse, low in magnitude, medium to long-term in duration, occurring within the RSA, and reversible. This was determined with a moderate level of confidence.

Figure 16.27 Model Results for Modelled Uncontrolled Well Event at EL 1144 Example Well Site in Relation to NAFO Subdivisions and Fishing Intensity

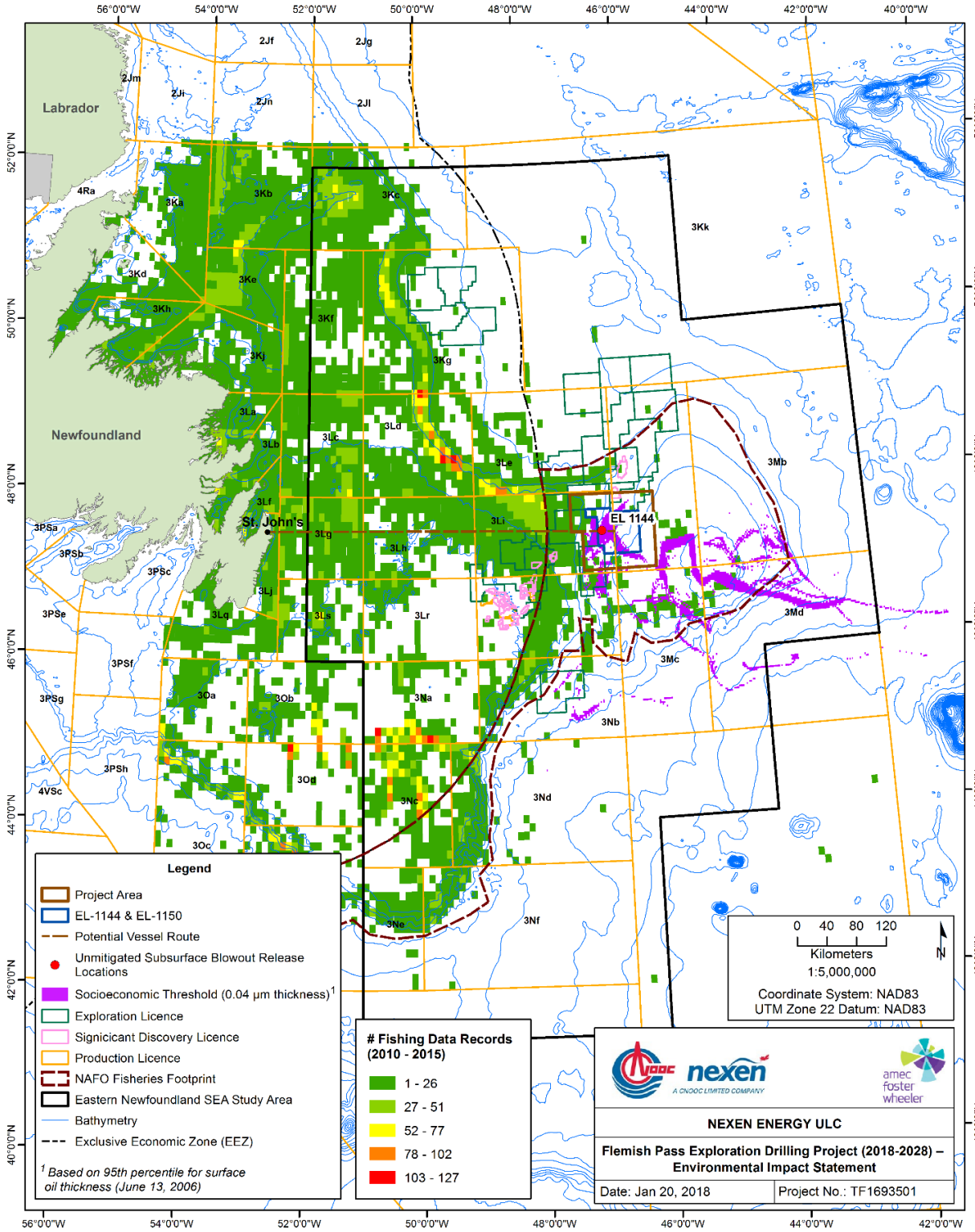
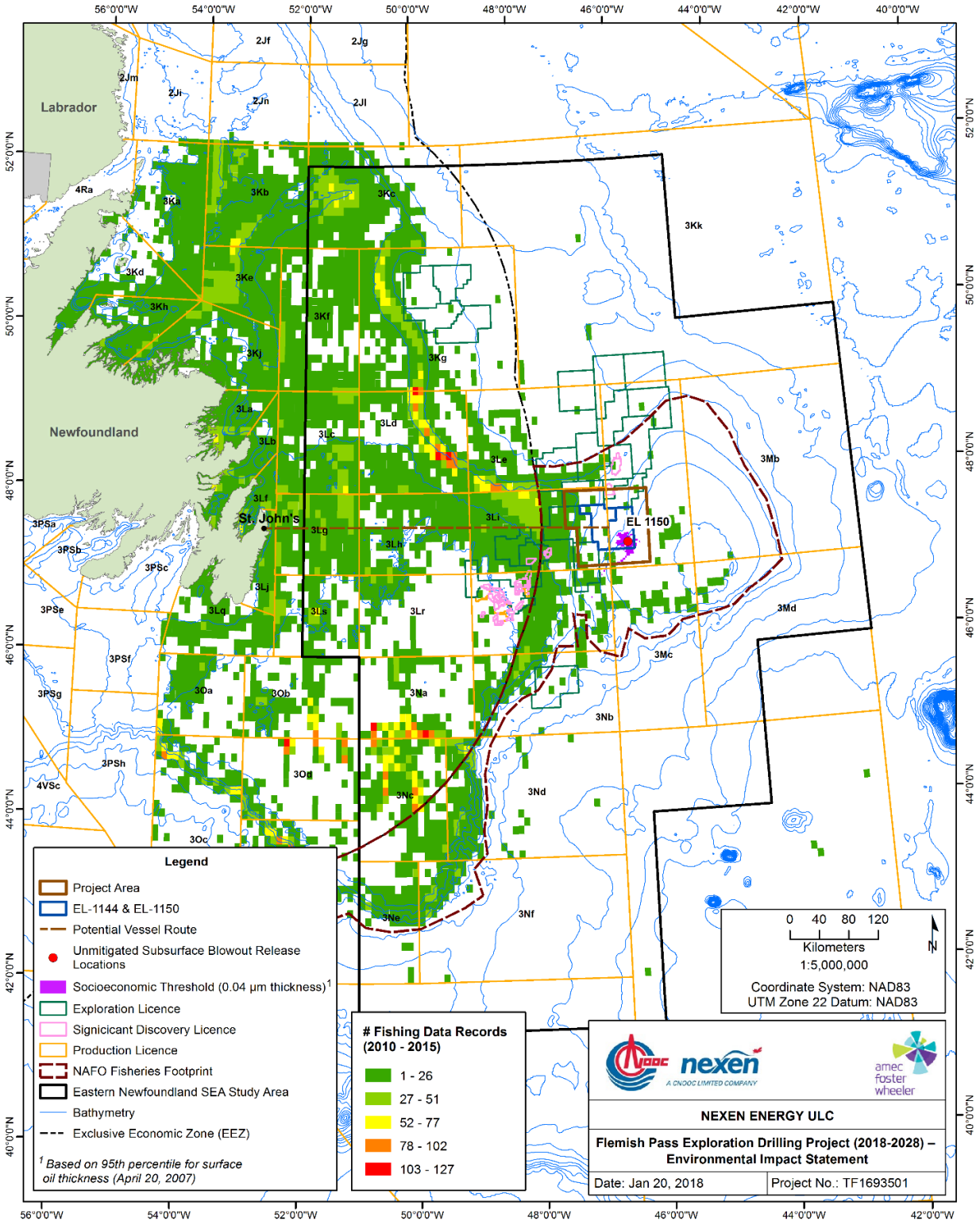


Figure 16.28 Model Results for Modelled Uncontrolled Well Event at EL 1150 Example Well Site in Relation to NAFO Subdivisions and Fishing Intensity



16.6.7.3 Summary and Determination of Significance

Table 16.24 provides a summary of predicted residual environmental effects of accidental event scenarios on fisheries and other ocean uses, given the conservative approach employed for spill modelling, and the implementation of mitigation measures to prevent and reduce effects from a spill.

Table 16.24 Summary of Residual Accidental Event-Related Environmental Effects on Fisheries and Other Ocean Uses

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Potential Effects: **Fisheries** • Direct interference with fishing or exclusion from established fishing grounds • Damage to fishing gear or vessels • Decreases in the abundance, distribution and actual or perceived quality of fisheries resources **Potential Effects**: **Other Ocean Uses** • Direct contact with and damage to in situ component • Interference with other marine activities							
100 L Diesel Spill	A	N-L	L-PA	S	N-O	R	H
1,000 L Diesel Spill	A	L	PA	M	N	R	H
750,000 Diesel Spill	A	L	PA-RSA	M	N	R	M
Drill Fluid (SBM) Spill	A	N	L	S	N	R	H
Subsurface Blowout – EL 1144 Example Well Site	A	L	RSA	M-L	N	R	M
Subsurface Blowout – EL 1150 Example Well Site	A	L	RSA	M-L	N	R	M

KEY

Nature / Direction:
P Positive
A Adverse
N Neutral (or No Effect)

Magnitude:
N Negligible
L Low
M Medium
H High

Geographic Extent:
L Localized
PA Within Project Area

Frequency:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Duration:
S Short term
M Medium term
L Long term
P Permanent

Reversibility:

Certainty in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Accidental Event Scenario	Residual Environmental Effects Summary Descriptors						
	Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
LSA Within LSA RSA Within RSA or Beyond			R Reversible I Irreversible				

Based on the result of spill modelling exercises, Project response plans and mitigation provisions, and the availability of financial compensation, the predicted residual environmental effects from an accidental event on fisheries and other ocean uses are evaluated as not significant. Not only is a large spill unlikely, but if it were to occur, its extent and duration would be reduced through response measures, and affected fishers would be compensated under the Operator Compensation Program, which includes provisions for lost and future lost income replacement, following the C-NLOPB Compensation Guidelines Respecting Damages relating to Offshore Petroleum Activities (2017).

Spill prevention techniques and response measures will be incorporated into the design and operations for all Project activities as part of contingency planning, which will further help to ensure that effects do not occur, and in the unlikely event they did, that these would not have significant adverse effects on fisheries and other ocean uses.

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17 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

As required under Section 19(1)(h) of CEAA 2012 and as specified in the EIS Guidelines (Part 2, Section 6.6.2), this chapter assesses and evaluates the potential effects of the environment on the Project.

The physical environmental setting of an area is an important consideration in the planning, review and conduct of offshore oil and gas exploration activities. An appropriate understanding, and careful consideration, of environmental characteristics and phenomena such as winds, waves, currents, ice, precipitation and other factors is required so that offshore activities can be designed and implemented appropriately, and in a manner that helps ensure that human health and safety and the environment, as well as ensuring that equipment and infrastructure are protected. This includes avoiding or reducing the potential for any incidents and accidents that may occur as a result of unplanned interactions between oil and gas operations and the physical environment of the marine area in question.

Section 17.1 provides an overview summary of some of the key environmental factors that could potentially affect the Project, including:

- Seismicity and geohazards
- Climatology, weather and oceanographic conditions
- Sea ice and icebergs, and
- Climate change

Much of the information presented in this section is summarized from the more detailed description of the existing physical environment presented in Chapter 5 of this EIS, which should be consulted for further details as well as for the sources of much of the information that is summarized here.

Section 17.2 then assesses the potential implications of the above noted environmental characteristics for Project planning, design and its eventual implementation, including the manner in which each of these potential issues will be considered and addressed as these aspects of the Project move forward.

17.1 Key Environmental Considerations

This section provides a summary of key environmental conditions and phenomena that are relevant to the potential effects of the environment on the Project.

17.1.1 Seismicity and Geohazards

The geology of the Eastern Newfoundland Offshore Area is complex and dynamic. The seabed geomorphology is primarily a product of modern oceanographic processes and past glacial activity.

Canada's eastern continental margin is tectonically passive and seismicity is relatively rare throughout much of the region. Natural Resources Canada (NRCan) indicates that the Project Area and surrounding areas have been classified as having a relatively low seismic hazard (NRCan 2017a, 2017b). According to the National Earthquake Database (NRCan 2017c) there have been no seismic events recorded within the boundaries of the Project Area within the 1985-2017 period, with the closest recorded event having occurred over 50 km away.

Potential offshore geohazards in and around the Project Area include a number of geological phenomena including, but not necessarily limited to, submarine slides, shallow gas and dissociation of gas hydrates and seismic events. Shallow gas can lead to excess pore pressure in permeable strata such as silts and can be a preconditioning factor for submarine landsliding. NRCan analysis indicates that in any given area offshore Eastern Canada, there is a risk of a landslide every 20,000 years and a minor one may occur every few thousand years (NRCan 2010). It is likely that most failures are earthquake triggered, with some seismicity induced by glacio-isostasy (Piper 2005). The natural risk of large slope failure is very low with a recurrence interval of 100,000 years. If one did occur, it would likely be preconditioned by high pore pressure and triggered by earthquakes. Generally, in the Flemish Pass area, the steep slopes, abundant shallow gas, and possibly greater seismicity make large landslides potentially more frequent, with a recurrence interval of 10,000 years. This translates to approximately a 1 in 500 risk of a landslide occurring over any 20 year period in the region (Cameron et al 2014).

17.1.2 Climatology, Weather and Oceanographic Conditions

Based on MSC50 hindcast data (Swail et al 2006), the mean annual wind speed (1-hour averages, 10 m elevation) for the Project Area is 8.9 m/s, while the maximum hourly wind speed is 34.3 m/s. The months with the highest mean wind speeds are typically January and February (11.7 and 11.5 m/s, respectively), which also have the highest maximum wind speeds (34.3 and 30.9 m/s, respectively). The most frequent wind directions for mean and maximum winds are predominately westerly and northwesterly respectively, but range from northwesterly to southeasterly. The range of wind conditions experienced along the potential vessel and aircraft traffic routes from Eastern Newfoundland to the Project Area are likely to be quite close to those experienced farther offshore, with the offshore winds being slightly higher. Exceedance values for wind speeds for various return periods are listed in Table 17.1 (see Section 5.3 for more details).

Table 17.1 Wind Speed Exceedance Values for Various Return Periods in the Project Area

Return Period	1-year	10-year	50-year	100-year
Wind Speed	25.6 m/s	29.6 m/s	32.6 m/s	33.8 m/s

According to the ICOADS (1960-2016), air temperatures in the Project Area exhibit strong seasonal variations, with mean temperatures ranging from 0.9°C in February to 12.9°C in August. The coldest observed air temperature on record (-12.0°C) was in February, while in summer the values reach as high as 24.0°C. Throughout the year the mean daily minimum and maximum temperatures generally stay within about 3°C of the mean temperature, due in part to the moderating effects of the ocean. Over the potential vessel and aircraft routes for the Project, conditions are on average fairly consistent with mean values between 0°C and 15°C year round (Bowyer 1995).

The ICOADS data also indicate that most of the observed precipitation events are in the form of rain, snow and drizzle, while other precipitation types, such as mixed rain, freezing rain, and hail occur far less frequently. Freezing rain is relatively infrequent in this area, occurring less than one percent of the time during any given month, and typically does not occur at all between July and November. Thunderstorms, which can generate hail and lightning, occur with similarly low frequencies, however there is a year-round potential of occurrence.

The Project Area and surrounding areas have some of the highest occurrence rates of marine fog in North America, and fog can persist for days or weeks. This type of fog (advection fog) is most prevalent

in spring and summer. Visibility is affected by the presence of fog, the number of daylight hours, as well as frequency and type of precipitation. Visibility within the Project Area varies considerably throughout the year. Good or fair visibility occur about 77.5 percent of the time annually. Good visibility (greater than 10 km) is most frequent during the fall, and least frequent in spring and summer. Visibility is poorest in July with conditions being very poor or poor over half the time. Annually, visibility is very poor 12.7 percent of the time, poor 9.8 percent of the time, fair 39.1 percent of the time, and good 38.4 percent of the time.

Based on MSC50 hindcast data (Swail et al 2006), monthly mean significant wave heights in the Project Area range from about 1.7 m in July to 4.5 m in January, with an annual mean of 3.0 m. The most severe sea states occur in December through February when maximum significant wave heights exceed 14.0 m. The largest waves are from the southwest through northwest directions with associated peak periods in the 15 to 17 s range. In contrast, the maximum significant wave height at 7.1 m is lowest in July, with an associated peak period of 12 s. Annually, mean wave heights are about two meters near St. John's compared with 3 to 3.5 m near the eastern portions of the Project Area. During fall and winter months, average wave heights can be expected to be 1.5 m higher than near St. John's, while maximum wave heights can be expected to be at least two meters higher. Exceedance values for significant wave heights for various return periods are listed in Table 17.2 below (see Section 5.3 for more details).

Table 17.2 Significant Wave Height Exceedance Values for Various Return Periods in the Project Area

Return Period	1-year	10-year	50-year	100-year
Wave Height	11.6 m	14.1 m	15.9 m	16.7 m

The offshore Labrador Current, which flows near the Project Area, has average speeds of about 40 cm/s, mainly between the 400 and 1,200 m isobaths (Lazier and Wright 1993). Over areas of the Grand Banks with water depths less than 100 m, the mean currents are generally weak (less than 10 cm/s) and flow southward, dominated by wind-induced and tidal current variability (Seaconsult Ltd. 1988). In the vicinity of the Flemish Pass, the Labrador Current divides into two branches with the main branch flowing southwards as Slope Water Current and the side branch flows up to the east-northeast clockwise past the Sackville Spur and north-eastward around the Flemish Cap. The cores of the currents are located at an average depth of 100 m (Greenan et al 2016). According to the BIO ODI database (Gregory 2004), currents measured near the Project Area have average speeds that range from eight to 43 cm/s for depths up to 500 m and range from 5 to 19 cm/s in deeper waters. Maximum current speeds of 97 cm/s were recorded February 1986, along the slope, eight kilometers southwest of the Project Area boundary at an instrument depth of 100 m. The deepest maximum current speeds are 60 cm/s measured near-bottom (1,369 m) located along the Sackville Spur at a mooring water depth of 1,400 m. These currents are substantially lower than many regions of the world and are well within the capability of modern MODUs, including their dynamic positioning systems.

Mean sea surface temperatures range from approximately 1.8°C in February to 11.9°C in August. Minimum temperatures at the surface range from -1.8°C in February to 9.5°C in September. Maximum sea surface temperatures range from 4.6°C in March to 15.7°C in August. This seasonal temperature cycle with cooler winter temperatures and warmer temperatures in summer is observed down to 200 m. For depths greater than 200 m, sea temperature is only slightly variable by depth with monthly mean temperatures ranging from 3.3 to 4.0°C. Sea surface salinities range from a minimum of 31.0 psu in July to a maximum of 34.7 psu in April with monthly averages that range by approximately 1, from 33.0

psu in July to 33.9 psu in February. For depths below 200 m, the variability in salinity is even less, with mean values ranging from 34.7 to 35.2 psu and averaging 34.8 psu.

Water level variations due to tides in the Project Area are generally quite predictable. Overall, the water levels exhibit two high tides and two low tides per day, with one set of tides having a higher tidal range than the other. Total tidal amplitude is in the range of 40 cm. Storm surge amplitudes can be particularly high in coastal areas, but surges with comparatively smaller amplitudes can also occur offshore. The expected storm surge levels range between 50 cm (1 year return period) and 73 cm (100 year return period) (Seaconsult 1998; Bernier and Thompson 2006).

17.1.3 Sea Ice and Icebergs

Portions of the Project Area are subject to seasonal intrusions of sea ice and icebergs. Ice conditions experience interannual and spatial variability, depending on winter conditions over Newfoundland and the surrounding waters as well as seasonal wind patterns. Cold and dry westerly to northerly winds tend to move ice further offshore, while northeasterly winds drive the ice towards shore.

Information drawn from the CIS Sea Ice Climatic Atlas for the East Coast 1981-2010 (CIS 2011) shows that a large variability in sea ice conditions can be experienced from year to year, as well as in any given year, on time scales of days to weeks and over comparatively small geographic scales of tens of kilometres. Sea ice is more likely of greater concentration and thickness in the western portions and less severe further offshore to the east. With passing weeks, as the ice advances, there is potential that thicker sea ice to the west and north will continue to drift farther offshore (south and east). There is potential for landfast ice (ice which forms and remains fast along the coast) nearshore which can extend from a few metres to several hundred kilometres offshore. This may pose a potential risk for potential vessel traffic routes near the coastline of Eastern Newfoundland, but is unlikely to be a factor in the Project Area itself.

Ice is typically present as early as mid- to late-January for the most-western portion of the Project Area and covers the entire Project Area by the week of 5 February and as late as mid- to late-April. The latest ice is usually seen the week of 30 April over only the western portion of the Project Area. The frequency of presence of sea ice during January and the first week of February is at least one to 15 percent, or about as frequent as every six or seven years. The first week of April is likely the most severe time for sea ice over the Project Area. Ice concentrations are mostly 9 to 9+/10 with patches of 7 to 8/10 to the west. By May the Project Area is normally ice free.

The NRC-PERD iceberg database (Sudom et al 2014; NRC 2015) shows 1,218 icebergs (first sightings) within the Project Area over the past 30 years, with sizes known for about two thirds of these observations. Of these icebergs, about 15 percent were growlers or bergy bits (less than one m in height, less than five m in length and mass about 500 t), 74 percent were small or medium, 10 percent were large, and one percent were very large (greater than 100 m in height, greater than 200 m in length, and mass over five Mtonnes).The iceberg season generally lasts from January through August, with 85 percent of first sightings during March through June. The 83 large icebergs sighted in the Project Area were observed in all months from January to August with 29 observed in May. Eight very large icebergs were seen in March (two icebergs) and April (six icebergs). Over the 30 year record, 1985-2014, there have been eight sightings after August in the Project Area: four in September, three in October and one in December. The number of icebergs reported (first sightings) annually for the Project Area varies and

has historically ranged from zero in numerous years, including the four years from 2004 to 2007, to a maximum of 217 in 2002 and has averaged 55 icebergs (Section 5.6).

17.1.4 Climate Change

Given the relatively short temporal duration of the Project (2018 to 2028), it is unlikely that the physical environment will experience significant climate change impacts beyond what is presently found in recent trends and interannual variability. It is therefore unlikely to have a direct and significant effect on the Project beyond the overall design and planning measures being undertaken to address the physical environmental parameters discussed above. Climate change is discussed in some detail in Section 5.7 of the EIS.

17.2 Assessing Potential Effects of the Environment on the Project

Environmental conditions play a key role in the planning and operation of offshore oil and gas exploration activities. This includes consideration of, and planning for, typical environmental conditions within the offshore area in question, as well as consideration of their seasonal and inter-annual variability and potential extreme events. This section provides an assessment of the potential effects of the physical environment on the Project. The various design and operational measures that will be implemented to mitigate these potential effects are then described in Section 17.3.

17.2.1 Seismicity and Geohazards

Although the Project Area has been classified by NRCan as having a relatively low seismic hazard, if a seismic event did occur it could result in seafloor instability and therefore disrupt Project equipment and activities. This could, in turn, potentially contribute to an accidental event such as an oil spill. Earthquakes significant enough to trigger submarine landslides or tsunamis are estimated to be magnitude 6 or greater, and these have not occurred within 1,000 km of the Project Area since the inception of NRCan's earthquake database in 1985. The closest significant earthquakes were a 7.2-magnitude event in 1929 (Laurentian Slope) as well as a 7.0-magnitude event in 1663 (Charlevois-Kamouraska, Quebec).

17.2.2 Climatology, Weather and Oceanographic Conditions

Adverse weather and oceanographic conditions, such as high winds, large waves or other severe weather (such as freezing precipitation) can influence operations and pose potential risks to human health, safety and the environment. These conditions may, for example, affect the overall stability and functioning of the MODU or support vessels, or influence the conduct of onboard activities and their safe, effective and efficient execution. In extreme situations, severe conditions may result in the required evacuation of the MODU, failure of the superstructure or capsizing, or otherwise result in an accidental spill or other unplanned event.

Adverse weather conditions within the Project Area can directly affect the nature and timing of a number of Project activities, including the movement and positioning of the MODU, transportation and receipt of personnel, equipment and other materials, drilling operations, other equipment deployment and use, and other Project components and activities. Ocean current loads, in addition to surface wave conditions, have the potential to exert stress on the MODU and its associated subsurface components.

Rough seas (high winds and waves) will likely influence vessel traffic to, from, and within the Project Area at times over the temporal duration of the Project. Fog is also a common occurrence in the region, and can be dangerous for offshore operations, particularly when ice or other hazards and human activities are present.

Superstructure icing, which can result from freezing precipitation or a combination of low ambient air temperature, low sea surface temperatures, and wind-induced sea spray can pose a risk to offshore operations. The freezing of salt spray typically results when the air temperature is below -1.8°C, sea temperature is below 6°C and wind speeds are greater than 10 m/s. Ice and snow build-up on the MODU and support vessels is primarily a safety issue for personnel, with the risk of falling ice and snow from overhead. Heavy icing can also result in a higher center of gravity and potential equipment damage.

Visibility can be reduced considerably as a result of rain, fog or snow conditions which can result in delays. Helicopter transits to and from the active MODUs will also require specific visibility criteria to be met in order to travel to and from this offshore area and to land on offshore installations. Thunderstorms can also affect aircraft movements as well due to the potential for lightning strikes, strong downbursts of wind, and hail.

17.2.3 Sea Ice and Icebergs

The Project Area is subject to seasonal intrusions of sea ice and icebergs. Ice conditions pose a seasonal - but significant - risk to operations offshore Newfoundland and Labrador. Support vessel navigation and delivery of personnel and supplies can be hindered by the presence of sea ice and icebergs, while these phenomena may also result in the need to suspend drilling operations and move the MODU to avoid collision. The main risks caused by sea ice is at the ocean surface, while icebergs also pose a risk to equipment tens of metres below the surface. Due to the water depths in the Project Area, there is minimal risk that iceberg scour will interact with infrastructure on or near the seabed.

17.3 Mitigating Potential Effects of the Environment on the Project

One of the main aspects of offshore exploration drilling program planning that is influenced by physical environmental conditions is the eventual selection of the MODU type and specific unit to be used. For this Project, both semi-submersibles and drill ships are under consideration, the eventual selection of which will depend largely upon the physical environmental conditions at the wellsite, including water depth and anticipated ice conditions and associated mobility requirements. Similarly, the selection and procurement of associated support vessels and aircraft will require consideration of the operational requirements for such equipment, including weather and marine conditions. Market availability may also influence the selection of the MODU, support vessels and aircraft.

All MODUs used offshore Newfoundland and Labrador must adhere to relevant regulatory requirements, including the Newfoundland Offshore Certificate of Fitness Regulations, which includes the issuance of a Certificate of Fitness from an independent, third-party Certifying Authority. This authority must confirm that the MODU meets the associated regulatory requirements, is fit for purpose, can function as intended, and is able to do so without compromising safety or having a detrimental impact on the environment. Any relevant modifications and repairs are also reviewed and must be accepted by the Certifying Authority to ensure the continued validity of the certificate. Nexen also has

its own internal MODU acceptance and inspection process and governance requirements that will be satisfied.

The Certificate of Fitness is required before the C-NLOPB is able to issue an Operations Authorization, which is required for all exploration drilling programs (Section 1.3). The standards against which the MODU will be evaluated consider physical environmental criteria, as well as the life of and appropriateness of expected design materials (e.g. with respect to corrosion resistance) and equipment. The *Newfoundland Offshore Certificate of Fitness Regulations* require that offshore installations must be designed, constructed, transported, and installed in accordance with Parts I to III of the *Newfoundland Offshore Petroleum Installations Regulations*.

17.3.1 Seismicity and Geohazards

Given the relatively short time period associated with the drilling of each well (see Section 2.5.2) it is very unlikely that a seismic event would occur and would have a direct or indirect (via landslides and tsunamis) detrimental effect on Project activities. The aforementioned Certificate of Fitness requires that the MODU be designed to accommodate and withstand seismic and related environmental loads. It must also have the capability of quickly disconnecting a riser from the well, which would help mitigate any potential damage in the event of a tsunami. A landslide, however, could cause wellhead and blowout preventer damage leading to breach of the primary barrier.

For this Project, wells will not be located on a highly sloped seabed where there is a higher probability of a landslide. Also, the wells will be positioned to avoid other geohazards. A seabed investigation and shallow hazards assessment will be conducted to identify the risk of potential geohazards. The well location, design, and/or operational plan will be adjusted to reduce the risk down to an acceptable level.

Although there is the possibility of the Project being affected by a seismically triggered tsunami, as noted previously the area is considered to be of relatively low risk for seismic activity. Given the relatively short duration of planned Project activities at any one location and the low probability of tsunami occurrence, it is unlikely that a tsunami would occur during, and therefore affect, Project operations.

17.3.2 Climatology, Weather and Oceanographic Conditions

Meteorological and oceanographic conditions in the Project Area will also be key considerations in the planning and execution of the offshore exploration and support activities that comprise this Project. This will include associated decisions about the required characteristics of the equipment to be used, including the eventual selection of the MODUs, support vessels, and aircraft as described earlier. Environmental conditions will also influence overall operational planning and decision-making throughout the life of the Project.

As noted previously, all MODUs, support vessels, aircraft and other equipment used for this Project will have the capacity to function within the environmental conditions that are known or likely to be encountered in the Project Area, and will adhere to all applicable regulatory requirements for safety and environmental protection. Proper operational planning as well as Project compliance with applicable international standards and Canadian regulations for equipment design and use with respect to extreme weather and oceanographic conditions will help to mitigate these risks. These include considerations and requirements related to operation in various environmental conditions including average and

extreme ambient temperatures, precipitation (including snow and freezing precipitation), ice accretion, wind, waves, tides, currents, sea ice, icebergs and any combination thereof. These criteria must be met in order for the aforementioned Certificate of Fitness to be issued.

By closely monitoring regional and local marine weather and ice conditions and receiving customized and frequently updated weather forecasts and alerts, Project personnel will be able to make informed decisions to address any such adverse weather conditions. While equipment will be selected for safe operation in such conditions, an appropriate measure of flexibility will be incorporated into short- and medium-term operational planning to account for potential delays caused by severe conditions that may occur beyond the weather forecast timeframe. This flexibility will be dictated in part by seasonality (e.g. typically harsher conditions in the winter and spring) and will help allow for long-term Project plans to be executed safely and efficiently.

As also mentioned above, the MODU and equipment, including riser and mooring where applicable, will be designed to withstand potential environmental loads in accordance with the Newfoundland Offshore Certificate of Fitness Regulations and will be able to quickly and safely disconnect from the well as required to mitigate any potential risks.

Superstructure icing issues are considered and addressed in the selection of equipment and the development of appropriate operational procedures to ensure that they can operate safely and effectively under these conditions. Icing conditions and accumulation rates will be monitored closely.

The regular monitoring of conditions and forecasts will inform the timing of Project-related vessel traffic as well as selection of specific navigation routes. Support vessels may also be affected by icing (as discussed above) which can result in slower vessel speeds, reduced maneuverability and problems with associated equipment (DFO 2012). The support vessels used for the Project will be equipped for safe operation in all weather conditions and sea states, including stability measures for operation in rough seas. The C-NLOPB requires that vessels have all relevant certificates in place as part of the pre-authorization process to ensure all-weather readiness. Any audits required are in addition to inspections conducted by Nexen as part of its own internal processes.

Aircraft must travel at reduced speeds in low visibility and may be prevented from landing on the MODU if visibility is below defined thresholds. Upon returning to St. John’s Airport the inbound visibility criteria are a runway visual range of 1,000 feet and a ceiling of 200 feet. Visibility forecasts will be used to inform personnel of expected conditions at scheduled departure, transit and arrival times. To enhance operation in limited visibility, the MODU must also adhere to specific navigation lighting requirements, and support vessels must be fitted with obstruction and navigation lights as well as foghorns. Reducing aircraft speed, adjusting flight altitude, and employing radar and other navigation equipment will also assist in navigating safely in low visibility. In order to ensure continuous communication between required offshore personnel, radio communication systems will be in place on helicopters, support vessels, the MODU and shore bases.

In order to accommodate any weather delays in the transportation of supplies, adequate food and potable water stores must also be maintained on the MODU.

The Offshore Physical Environment Guidelines (NEB et al 2008) require that offshore operators implement a physical environment monitoring program. This includes monitoring of meteorological

conditions and onsite weather observation, ice management, and other met ocean and marine monitoring and forecasting. Meteorological condition monitoring includes winds, precipitation, temperature, and visibility, while oceanographic monitoring includes waves and currents. Sea ice and iceberg monitoring will also take place, as discussed in the following section. The collection and analysis of detailed and site-specific information on climatic and meteorological conditions and oceanographic characteristics are also typically part of an operator's overall planning and design of an offshore program and its associated regulatory review and approval requirements. This information contributes to appropriate equipment selection, program scheduling, and the development of operational procedures, all of which are key factors to help ensure safe operations and reduced risks to personnel, environment, equipment and vessels.

In addition to pre-commencement analysis and planning, meteorological and oceanographic monitoring programs are often implemented throughout offshore programs to forecast and plan for any severe environmental conditions. In situ monitoring and observations programs are essential to support weather and marine forecasting, which will be obtained from a contracted third-party forecaster. Environment and Climate Change Canada issues marine weather observations, forecast bulletins, special weather statements, watches, alerts, and warnings via the Meteorological Service of Canada (MSC's Automated Telephone Answering Device), Weatheradio (continuously broadcast over VHF or FM radio), and regional Storm Prediction Centres. The Newfoundland and Labrador Weather Office in Gander provides year-round marine weather and wave height information for waters around Newfoundland and Labrador, out to approximately 250 nautical miles (DFO 2015).

These forecasts will be monitored by the appropriate personnel onboard the MODU, support vessels and aircraft, as well as by Nexen onshore operations and logistics teams, each of whom have the authority to suspend or modify operations if forecasted adverse weather conditions could compromise the safety of personnel or operations.

17.3.3 Sea Ice and Icebergs

Ice monitoring / observation and management is a vital component in the reduction of ice related risks required by the Offshore Physical Environmental Guidelines (NEB et al 2008) and has been conducted and continuously improved offshore Newfoundland and Labrador for several decades. These guidelines state that offshore operators are required to prepare and submit an Ice Management Plan as part of the C-NLOPB's Operations Authorization process. Project-specific ice management plans are typically developed by operators and include procedures related to ice detection, monitoring and assessment as well as physical management. There is a coordinated ice management approach amongst the offshore oil and gas operators in Newfoundland and Labrador, which facilitates sharing of information (including ice detection and monitoring) as well as physical management resources.

A number of initiatives are in place to detect and monitor sea ice and icebergs in the region. These include dedicated ice observers, aerial reconnaissance using radar-equipped aircraft, long-range shore-based radars, as well as satellite observations. A daily summary of ice distribution is created by integrating data from each of these sources and subsequently provided to offshore operators during the ice season, which allows them to monitor ice conditions in their region. To supplement this regional approach, monitoring and radar equipment aboard the MODU will be optimized for the detection of nearby, smaller ice masses. All of this information can then be used to plan any required ice management responses for site-specific conditions.

Ice management is a required activity that is part of normal operations during the ice season offshore Eastern Newfoundland. Should ice pose a threat to the MODU, Project personnel, the environment or other equipment an emergency situation may be initiated. The ice management process will be documented in Nexen's Ice Management Plan for Operations, which has the intent of preventing an emergency situation. If an emergency is declared, the Emergency Response Plan will then be activated. These ice management processes will include established procedures for iceberg towing and deflection. Physical iceberg management involves towing or deflecting the iceberg from its free-drifting trajectory using tow ropes or a net. This is conducted as far upstream of offshore operations as possible to ensure that potentially hazardous icebergs are moved safely out of range. Physical management for sea ice is also commonplace in Canadian waters, and typically involves using support vessels to break up large ice floes that meet or exceed the design limits of support vessels or the MODU. An alternative approach is to use support vessel-mounted water cannons to open a path in the sea ice as it advances toward the platform. Procedures will also be in place for the safe disconnect and movement of the MODU while leaving the well in a safe and stable condition.

17.4 Effects Summary and Evaluation

As described in the preceding sections, some of the key environmental factors that could adversely affect the Project include severe weather conditions (such as high winds, low visibility and freezing precipitation), superstructure icing, extreme waves and ocean currents, as well as sea ice and icebergs. Seismicity and geological stability are also considerations, although such events have a low probability of occurrence.

The primary mitigation measures for such effects include appropriate engineering design and equipment selection, and adherence to applicable regulatory requirements and guidelines, operational procedures, and standard offshore industry practices. Additionally, as the proposed exploration activities that comprise this Project have a relatively short duration and do not involve the development of fixed offshore infrastructure, the likelihood of an extreme event and associated effects occurring are greatly reduced. Appropriate design and operational standards and regulations will be adhered to, and meteorological, oceanographic and ice conditions will be constantly monitored and considered in planning and decision-making throughout the life of the Project. All of these measures will help to reduce the potential for, and possible magnitude of, any adverse effects of the environment on the Project.

Significant adverse residual effects are defined as those where physical environmental conditions have an unplanned effect on Project components or activities that result in detectable, adverse effects to human health and safety, environment risks or the damage of key equipment or infrastructure resulting in effects on overall Project costs or schedule.

With the application of the aforementioned risk mitigation including adherence to the Newfoundland Offshore Certificate of Fitness Regulations, Newfoundland Offshore Petroleum Installations Regulations and the Offshore Physical Environmental Guidelines, significant adverse residual effects of the environment on the Project are not likely to occur.

In addition to the physical environmental components assessed above, other aspects of the existing biophysical and socioeconomic environments will also be a key consideration in the planning and conduct of the Project. The information, analysis, and findings of this EIS will also therefore play a key

role in such planning as the Project moves forward, in order to avoid or reduce the potential for adverse effects.

17.5 References

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18 EIS SUMMARY AND CONCLUSION

Nexen is planning to conduct an offshore exploration drilling program in the eastern portion of the Canada-Newfoundland and Labrador Offshore Area over the period 2018 to 2028. The Project Area includes two Exploration Licences (ELs 1144 and 1150) in the Flemish Pass region for which Nexen is currently the Operator and sole interest holder, and which have not yet been subject to exploration drilling activity to date pursuant to these licences. The Project will include exploration drilling within these ELs, possible appraisal (delineation) drilling in the event of a hydrocarbon discovery, VSP, well testing, eventual well abandonment or suspension activities, and associated supply and service activities.

The Project requires review and approval pursuant to the requirements of CEAA 2012. This EIS has been planned, prepared and submitted by Nexen in accordance with requirements of CEAA 2012, as well as being designed and completed to address the EA requirements of the C-NLOPB under the Accord Acts. It provides the required information on the Project and its potential environmental effects and associated mitigation, including the:

- Project purpose
- Project description (components, activities, schedule)
- Project alternatives
- Changes to the Project that may be caused by the environment
- Existing environmental setting (biophysical and socioeconomic)
- Government, stakeholder, and Indigenous engagement activities, including the various comments provided
- Environmental effects of the Project (planned activities and potential accidental events)
- Mitigation measures to avoid or reduce environmental effects of the Project
- Predicted residual effects and their significance
- Predicted cumulative environmental effects
- Any proposed environmental monitoring and follow-up activities

The EIS has been planned, completed and submitted in compliance with the Project-specific EIS Guidelines (July 2017) issued to Nexen by the Agency, which outline the factors to be considered in the assessment and the scope of those factors, as well as specifying particular requirements for environmental information and analysis that must be included in the EIS. These items have been considered and addressed in establishing the scope, focus, and spatial and temporal boundaries of the analysis and the overall content of the EIS, including the description of the Project (Chapter 2), the planning and implementation of EA-related engagement activities by Nexen (Chapter 3), the description of the existing environments (Chapters 5-7) and in the environmental effects assessments (Chapters 8-16). A detailed Table of Concordance that outlines the specific requirements and where they have been addressed is provided at the beginning of this EIS.

This chapter provides a summary of the key results and conclusions of the EIS, including the Project's predicted residual environmental effects, associated mitigation commitments, and any planned environmental monitoring and follow-up initiatives.

18.1 Summary of Potential Effects

In keeping with recent EAs for other oil and gas related exploration projects offshore Newfoundland and Labrador and elsewhere, the following VCs are considered in this EIS:

- Marine Fish and Fish Habitat (including Species at Risk);
- Marine and Migratory Birds (including Species at Risk);
- Marine Mammals and Sea Turtles (including Species at Risk);
- Special Areas;
- Indigenous Peoples;
- Fisheries and Other Ocean Uses; and
- Atmospheric Environment

As a first step in assessing the potential effects of the Project on each of the selected VCs, spatial and temporal boundaries were established, within which potential Project-related environmental changes and resulting effects on the VC were assessed and evaluated, as well as a set of VC-specific significance definitions (criteria). In order to identify and focus on key environmental issues, and to help ensure that these are fully considered and addressed in the EIS, the assessment of potential effects on each VC considers the various questions and issues that have been identified in the EIS Guidelines, as well as those identified through Nexen's engagement with relevant government departments and agencies, Indigenous groups and stakeholder organizations(Chapter 3).

Based on the issues scoping exercise, the environmental effects assessment focuses on likely environmental interactions between the Project and the VC, and particularly, the associated environmental changes and resulting effects that may potentially occur as result. A summary overview of the potential for each of the Project's planned components and activities to result in one or more of the identified potential environmental effects is presented in Table 18.1.

Table 18.1 Summary of Potential Project-VC Interactions and Associated Effects

Potential Environmental Effects	Presence and Operation of MODUs	Drilling and Associated Marine Discharges	VSP	Well Testing	Well Abandonment or Suspension	Supply and Servicing
Marine Fish and Fish Habitat						
Change in habitat availability and quality	●	●				
Change in food availability and quality	●	●				
Change in fish mortality, injury, health	●	●	●	●		●
Change in fish presence and abundance (behavioral effects)	●	●	●		●	●
Marine and Migratory Birds						
Change in mortality / injury levels and bird health	●	●	●	●		●
Change in avifauna	●		●	●		●

Potential Environmental Effects	Presence and Operation of MODUs	Drilling and Associated Marine Discharges	VSP	Well Testing	Well Abandonment or Suspension	Supply and Servicing
presence and abundance (behavioral effects)						
Change in habitat availability and quality	●					
Change in food availability and quality	●	●	●			
Marine Mammals and Sea Turtles						
Change in mortality / injury levels and health (individuals or populations)	●	●	●	●		●
Change in habitat availability, quality and use (behavioral effects)	●	●	●	●	●	●
Change in food availability or quality	●	●	●	●	●	●
Special Areas						
Change in environmental features and/or processes	●	●	●	●	●	●
Change in human use and/or societal value	●	●	●			●
Indigenous Peoples						
Change in health and socio-economic conditions	●	●		●		●
Change in the current use of lands and resources for traditional purposes	●	●	●	●	●	●
Change in physical and cultural heritage and change in any structure, site, or thing that is of historical, archaeological, paleontological or architectural significance	●	●				●
Fisheries and Other Ocean Uses						
Direct interference with fishing or exclusion from established fishing grounds	●		●		●	●
Damage to fishing gear or vessels	●	●	●		●	●

Potential Environmental Effects	Presence and Operation of MODUs	Drilling and Associated Marine Discharges	VSP	Well Testing	Well Abandonment or Suspension	Supply and Servicing
Decreases in the abundance, distribution and actual or perceived quality of fisheries resources	●	●	●	●		●
Direct contact with and damage to in situ component	●	●				
Interference with other marine activities	●		●		●	●
Atmospheric Environment						
Change in air quality	●		●	●	●	●
Change in GHG levels	●		●	●	●	●

18.2 Summary of Mitigation

Mitigation measures, as defined under CEAA 2012, refer to measures for the elimination, reduction or control of a project's potential adverse environmental effects. To help avoid or reduce the potential adverse effects of the Project, general and issue-specific mitigation measures are identified and proposed in this EIS, based upon current industry practice and standards, applicable regulatory requirements, those suggested through Nexen's engagement with regulatory authorities, stakeholders and Indigenous groups (Chapter 3), and as defined through the professional judgment of the EIS team. A summary of the various mitigation measures and commitments set out in the EIS is provided in Table 18.2.

The application of these mitigation measures is considered in a fully integrated manner in the environmental effects assessment. This includes technically and economically feasible measures that have been "built-in" to the Project through its planning and design, so as to proactively avoid or reduce potential adverse environmental effects, those required by applicable regulations and guidelines, as well as any other mitigation measures identified by Nexen as part of the effects analysis that is reported in this EIS.

Table 18.2 Summary of Proposed Mitigation Measures and Their Relevance to each VC *

Mitigation Measures	VCs						
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
Planned Project Components and Activities							
The selection and screening of chemicals will be undertaken pursuant to the OCSG. Where technically feasible, lower toxicity drilling fluids and chemicals will preferentially be used.	●	●	●	●	●	●	
Treating operational discharges (such as sewage, deck drainage, bilge / cooling water, wash fluids, produced water, other waste) prior to release in compliance with the OWTG, MARPOL and other applicable regulations and standards.	●	●	●	●	●	●	
Oil-water separators will be used to treat contained oil-contaminated fluids, with collected oil properly stored and disposed of.	●	●	●	●	●	●	
Appropriate measures for the handling, storage, transportation and on-shore disposal of solid and hazardous wastes will be implemented throughout the Project.	●	●	●	●	●	●	
Complying with the *Canadian Environmental Protection Act*, the National Ambient Air Quality Objectives, the Newfoundland *Air Pollution Control Regulations*, and MARPOL Regulations for criteria air contaminants in exhaust.	●	●	●	●	●	●	●
During drilling activities that occur after the riser has been installed, SBM associated drill cuttings will be returned to the MODU and treated in accordance with the OWTG before being discharged to the marine environment. SBM drill cuttings are typically discharged below the sea surface in order to maximize their dispersion and thus, to help avoid or reduce any associated surface sheen and their accumulation on the seabed	●	●	●	●	●	●	
Project-related artificial lighting will be minimized to the greatest extent possible without compromising safety.	●	●	●	●	●	●	
Local vessels, MODUs and equipment will be used where technically suitable and available to reduce the potential for introduction of aquatic invasive species. All foreign vessels used for the Project operating in Canadian jurisdiction will comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act, 2001* during any ballasting and de ballasting activities. This may include requiring all foreign vessels and	●	●	●	●	●	●	

Mitigation Measures	VCs						
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
MODUs to carry out ballast tank or system flushing prior to arriving in Canadian waters to mitigate the spread of alien invasive species.							
Prior to the start of drilling activity a seabed investigation will be undertaken with a drop camera / video system to investigate the potential presence of sensitive benthic organisms or habitats in the immediate area of the wellsite. Should coral colonies (as defined in Section 8.3.2) be observed within or in proximity to a planned wellsite location, a 100 m “set-back” from these organisms will be applied to avoid or reduce the potential for direct interaction with sensitive organisms or other potential effects (such as smothering or sedimentation from drill cuttings disposal or sedimentation). If moving the wellsite in this manner is not feasible, Nexen will consult with the C-NLOPB to determine an appropriate course of action.	●			●	●	●	
During any associated well testing, any produced hydrocarbons and small amounts of produced water will be flared using high-efficiency burners. If there is a significant amount of produced water encountered, it will be treated in accordance with the relevant regulatory requirements prior to ocean discharge.	●	●	●	●	●	●	●
For any required VSP surveys Nexen will operate in compliance with the relevant aspects of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment.* Seismic sound levels for VSP will be kept at the minimum level possible based on the associated technical requirements for the survey.	●	●	●	●	●	●	
At the commencement of the VSP survey, a gradual "ramp-up" procedure of the seismic sound array will be implemented to allow any mobile marine animals to move away from the area if they are disturbed by it. There will also be a planned shut-down of the seismic sound arrays or reduction to the smallest, single source element during any required maintenance activities.	●	●	●	●	●	●	
Trained MMOs will monitor and report on marine mammal and sea turtle sightings during VSP surveys. This will enable sound source array shutdown or delay actions to be implemented if marine mammal or sea turtle species listed on			●	●	●		

Mitigation Measures	VCs						
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
Schedule 1 of the SARA are detected within the monitored exclusion zone							
If removal of the wellhead is required as part of abandonment procedures, it will be completed via mechanical separation (i.e., cutting, as opposed to the use of explosives). .	●		●	●	●	●	
Nexen will operate in accordance with the *Measures to Protect and Monitor Seabirds in Petroleum-Related Activity in the Canada-Newfoundland and Labrador Offshore Area*.		●		●	●		
Where possible, known and observed bird colonies, other significant aggregations of avifauna, and other identified sensitive areas will be avoided in the conduct of Project-related exploration activities as per requirements of the *Seabird Ecological Reserve Regulations, 2015*.		●		●	●		
The frequency of vessel and aircraft traffic transits associated with the Project will be minimized to the extent possible.		●		●	●	●	●
Maceration of sewage and kitchen waste will be conducted in accordance with MARPOL and the OWTG.	●	●	●	●	●	●	
Flaring will be kept to the minimum amount necessary to characterize the hydrocarbon accumulation and as necessary for the safety of the operation. High efficiency burners will be used when flaring is required, and the Project will consider flare shields if technically and safely feasible. Nexen will notify the C-NLOPB of plans to flare so that the Board may consult with ECCC-CWS to determine a safe timeline to proceed to minimize effects on migratory birds.		●		●	●		●
Routine searches for stranded birds will be conducted on the MODUs and supply vessels, and appropriate programs and protocols for the collection and release of marine and migratory birds will be implemented for any birds that become stranded. Nexen will obtain the necessary Seabird Handling Permit from ECCC-CWS.		●		●	●		
Existing and common vessel travel routes will be used wherever practical, vessels will seek to maintain a steady course and vessel speed			●	●	●	●	
There will be continuing communications and regular information exchanges (FFAW-Unifor, DFO Science Branch, One Ocean, other stakeholders) about current fishing plans and current Project						●	

Mitigation Measures	VCs						
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
activities. It is also expected that regular updates will be submitted to the C-NLOPB before each year's operations commence, which will report on recent information exchanges, updates, any changes in the fisheries (including any new fisheries) and current-year Project plans and schedules and associated mitigations.							
At-sea monitoring of and direct communications with vessels (radar, AIS, direct at-sea radio communications), and use of AIS by all sea-going Project vessels.						●	
The establishment and communication of identified safety zones (with ship hailing protocols and other measures) to protect the safety of personnel and equipment and eliminate the risk of fishing gear or vessel damage near the MODU.						●	
The establishment, implementation and communication of a *Fishing Gear Damage or Loss Compensation Program*, in accordance with applicable C-NLOPB requirements, to address any unplanned interactions between Project components and commercial fishing equipment.						●	
The use of a FLO on board vessels and during MODU movements as appropriate; the requirement for this to be determined in discussion with regulatory authorities and the FFAW-Unifor in accordance with the Risk Management Matrix Guidelines developed by One Ocean.						●	
The designation and use of a SPOC during marine operations to facilitate project-fishing industry communications in real time, and to respond to gear / vessel damage claims.						●	
Notices to Shipping / Notices to Mariners for planned Project activities (including activity, safety zones, installation locations and timing), and information about contacting Project representatives (e.g. the SPOC).						●	
The communication of the locations of any wellheads left in place to harvesters and other marine users and appropriate authorities for inclusion on nautical charts for the information of commercial fishers and other mariners as applicable.						●	
Surveying drill locations for the presence of UXO and shipwrecks before equipment is placed and drilling begins; treatment of suspected UXO						●	

Mitigation Measures	VCs						
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
according to Notices to Mariners Annual Edition (2017) Section 37, and reporting to DND.							
Avoiding existing subsea cables within the ELs when deciding on drilling locations.						●	
Identification and avoidance of other offshore petroleum installations and their safety zones.						●	
Identifying a specific point of contact for MARLANT queries and concerns, and to ensure engagement of CPF 84, through Director General Naval Strategic Readiness (DGNSR), to ensure de-confliction with possible Allied submarine activities.						●	
Awareness of and adherence to relevant sections of Section F (National Defense – Military Notices) of Notices to Mariners Annual Edition (2017) with respect to possible military activities.						●	
Overall adherence to the *Canada Shipping Act, 2001* (and *Collision Regulations*).						●	
Engines will be operated and maintained according to manufacturer's recommendations.							●
Emission sources will comply with applicable limits set out in Canada's *Vessel Pollution and Dangerous Chemicals Regulations*.							●
Sulphur content in diesel fuel used for the Project will meet current regulatory requirements (as per Regulation SOR/2002-254).							●
Accidental Events							
Adherence to all applicable regulations, authorizations / approvals and guidelines related to spill prevention and response	●	●	●	●	●	●	●
Spill prevention plans and procedures as required by the C-NLOPB, will be developed and submitted for approval to the C-NLOPB as a requirement of the Operations Authorization and will include, at a minimum, the following: • Training of project personnel • Spill Response equipment for containment (e.g., booms) and/or removal • Implementation of measures to deter birds from contacting spilled oil (e.g., bird scaring devices) • Shoreline response measures, if oil is predicted to contact shoreline • Shoreline clean-up measures, if in the event oil contacts shoreline	●	●	●	●	●	●	●

Mitigation Measures	VCs						
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Indigenous Peoples	Fisheries and Other Ocean Uses	Atmospheric Environment
• Measure to be implemented for the rehabilitation and recovery of oiled seabirds • Overview of monitoring that could be conducted in relation to various spill events							
Effects of the Environment on the Project							
MODU selection and applicable certifications / authorizations to address local environmental conditions	●	●	●	●	●	●	●
Physical environment data observations, weather forecasting, and reporting will be conducted in accordance with the *Offshore Physical Environmental Guidelines.* Physical environmental conditions will influence on-going operational planning and decision-making	●	●	●	●	●	●	●
Implementation of an Ice Management Plan. Options to be investigated for ice management include: ice detecting radar on MODUs, use of satellite data to monitor for presence of ice	●	●	●	●	●	●	●
Ability to quickly and safely disconnect riser in event of emergency.	●	●	●	●	●	●	●
* Table includes where the mitigation measure is directly and/or indirectly relevant to addressing potential adverse effects on each VC							

18.3 Residual Environmental Effects

In keeping with standard EA approaches the environmental effects assessment is focused upon assessing and describing the likely residual environmental effects of the Project – namely, those predicted to occur following the implementation of the mitigation measures identified and proposed in the EIS and summarized in the preceding section. The effects assessment for each VC has been structured to consider and address each planned Project component or activity (Table 18.3) and potential accidental events (Table 18.4).

Where available and applicable, the effects assessment considers and utilizes relevant scientific, engineering, community, stakeholder, and Indigenous knowledge and perspectives, and includes the analysis of possible Project-related environmental interactions, changes and associated environmental effects to the VC. The assessment also recognizes and considers the interactions and interrelationships between environmental components and systems and any predicted environmental effects. The predicted (residual) environmental effects of the Project are characterized based on a number of standard and widely accepted environmental effects criteria or “descriptors”, as illustrated in Tables 18.3 and 18.4, the key for which is provided below.

The environmental effects assessment for each VC concludes with a summary of the predicted residual environmental effects of the Project's planned components and activities, and evaluates the significance of these based on the VC-specific significance definitions presented at the beginning of each VC chapter. Any key sources of uncertainty or assumptions made in defining and determining significance are also presented and justified where relevant. If significant effects are predicted, the likelihood of their occurrence is also evaluated and described.

KEY FOR TABLES 18.3 AND 18.4

Nature / Direction:

P	Positive
A	Adverse
N	Neutral (or No Effect)

Magnitude:

N	Negligible
L	Low
M	Medium
H	High

Geographic Extent:

L	Localized, In Immediate Vicinity of Activity
PA	Within Project Area
LSA	Within LSA
RSA	Within RSA or Beyond

Frequency:

N	Not likely to occur
O	Occurs once
S	Occurs sporadically
R	Occurs on a regular basis
C	Occurs continuously

Duration:

S	Short term (For duration of the activity / disturbance)
M	Medium term (Beyond duration of the activity / disturbance – weeks or months)
L	Long term (Beyond duration of the activity / disturbance – years)
P	Permanent (Recovery unlikely)

Reversibility:

R	Reversible (Will recover to baseline)
I	Irreversible (Permanent)

Certainty in Predictions:

L	Low level of confidence
M	Moderate level of confidence
H	High level of confidence

Significance:

N	Not Significant
S	Significant

Note: See significance definitions provided for each VC in Chapters 8-14.

n/a	Not Applicable

Table 18.3 Summary of Predicted Residual Environmental Effects for Planned Project Activities

VC	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effects	Project Activity	Mitigation	Residual Effect Characterization							Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty			
Marine Fish and Fish Habitat	s. 5(1)(a)(i)	• Change in habitat availability and quality • Change in food availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance (behavioral effects)	Presence and Operation of MODUs	See Table 18.2	A	L	L-LSA	S-M	R	R	H	Ecological / Socioeconomic Context as summarized in Table 8.7 of the EIS	N	n/a
			Drilling and Associated Marine Discharges		A	L	L-LSA	M-L	C	R	H		N	n/a
			Vertical Seismic Profiling		A	L	LSA	S	S	R	H		N	n/a
			Well Testing		A	L	L	S	S	R	H		N	n/a
			Well Abandonment or Suspension		A	N-L	L	S	S	R	H		N	n/a
			Supply and Servicing		A	L	L	S	R	R	H		N	n/a
Marine and Migratory Birds	s. 5(1)(a)(iii)	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance (behavioral effects) • Change in habitat availability and quality • Change in food availability or quality	Presence and Operation of MODUs	See Table 18.2	A	L	L-LSA	S-M	R	R	H	Ecological / Socioeconomic Context as summarized in Table 9.4 of the EIS	N	n/a
			Drilling and Associated Marine Discharges		N-A	N	L	S	S	R	H		N	n/a
			Vertical Seismic Profiling		N-A	N	L	S	S	R	H		N	n/a
			Well Testing		A	L	L-LSA	S	S	R	H		N	n/a
			Well Abandonment or Suspension		N	-	-	-	-	-	H		N	n/a
			Supply and Servicing		A	L	L	S	R	R	H		N	n/a
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	• Change in mortality / injury levels and health • Change in habitat availability, quality and use • Change in food availability or quality	Presence and Operation of MODUs	See Table 18.2	A	L-M	L-LSA	S-M	R	R	M	Ecological / Socioeconomic Context as summarized in Table 10.5 of the EIS	N	n/a
			Drilling and Associated Marine Discharges		A	N	L	S	S	R	H		N	n/a
			Vertical Seismic Profiling		A	L	L-LSA	S	S	R	H		N	n/a
			Well Testing		A	N-L	L-PA	S	S	R	H		N	n/a
			Well Abandonment or Suspension		A	N-L	L	S	S	R	H		N	n/a
			Supply and Servicing		A	L	L	S	R	R	H		N	n/a
Special Areas	s. 5(1)(b)(i)	• Possible change in environmental features and/or processes • Possible change in human use and/or societal value	Presence and Operation of MODUs	See Table 18.2	N-A	N	L	S	R-S	R	H	Ecological / Socioeconomic Context as summarized in Table 11.4 of the EIS	N	n/a
			Drilling and Associated Marine Discharges		N-A	N	L	S	S	R	H		N	n/a
			Vertical Seismic Profiling		N-A	N	L	S	S	R	H		N	n/a
			Well Testing		N-A	N	L	S	S	R	H		N	n/a
			Well Abandonment or Suspension		N-A	N	L	S	S	R	H		N	n/a
			Supply and Servicing		N-A	N	L	S	R	R	H		N	n/a

VC	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effects	Project Activity	Mitigation	Residual Effect Characterization							Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty			
Indigenous Peoples	s.5(1)(c)(i) s.5(1)(c)(iii)	• Change in health and socio-economic conditions • Change in the current use of lands and resources for traditional purposes • Change in physical and cultural heritage • Change in any structure, site or thing that is of historical, archaeological, paleontological or architectural significance	Presence and Operation of MODUs	See Table 18.2	N	-	-	-	-	-	H	Ecological / Socioeconomic Context as summarized in Table 12.10 of the EIS	N	n/a
			Drilling and Associated Marine Discharges		N	-	-	-	-	-	H		N	n/a
			Vertical Seismic Profiling		N	-	-	-	-	-	H		N	n/a
			Well Testing		N	-	-	-	-	-	H		N	n/a
			Well Abandonment or Suspension		N	-	-	-	-	-	H		N	n/a
			Supply and Servicing		N	-	-	-	-	-	H		N	n/a
Fisheries and Other Ocean Uses	s. 5(2)(b)(i)	• Direct interference with fishing activity or exclusion from established fishing grounds • Damage to fishing gear or vessels • Decreases in the abundance, distribution and actual or perceived quality of fisheries resources • Direct contact with and damage to in situ component • Interference with other marine activities	Presence and Operation of MODUs	See Table 18.2	A	L	L-PA	S-M	R	R	H	Ecological / Socioeconomic Context as summarized in Tables 13.5 and 13.6 of the EIS	N	n/a
			Drilling and Associated Marine Discharges		N-A	N	L-PA	S-M	S	R	H		N	n/a
			Vertical Seismic Profiling		N-A	N	L	S	S	R	H		N	n/a
			Well Testing		N-A	N	L	S	S	R	H		N	n/a
			Well Abandonment or Suspension		N-A	N	L	S-P	S	R-I	H		N	n/a
			Supply and Servicing		N-A	N	L	S	R	R	H		N	n/a
Atmospheric Environment	s. 5(2)(a)	• Change in air quality • Change in GHG levels	Presence and Operation of MODUs	See Table 18.2	A	L	L-LSA	S	C	R	H	Ecological / Socioeconomic Context as summarized in Table 14.13 of the EIS	N	n/a
			Drilling and Associated Marine Discharges		N	-	-	-	-	-	H		N	n/a
			Vertical Seismic Profiling		A	L	L-LSA	S	S	R	H		N	n/a
			Well Testing		A	L	L-LSA	S	S	R	H		N	n/a
			Well Abandonment or Suspension		A	L	L-LSA	S	S	R	H		N	n/a
			Supply and Servicing		A	L	L-LSA	S	R	R	H		N	n/a

Table 18.4 Summary of Predicted Residual Environmental Effects for Accidental Events

VC	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effects	Project Activity (Potential Event)	Mitigation	Residual Effect Characterization							Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty			
Marine Fish and Fish Habitat	s. 5(1)(a)(i)	• Change in habitat availability and quality • Change in food availability and quality • Change in fish mortality, injury, health • Change in fish presence and abundance (behavioral effects)	100 litre Diesel Spill	See Table 18.2	A	N-L	L-PA	S	N-O	R	H	Ecological / Socioeconomic Context as summarized in Table 8.7 of the EIS	N	n/a
			1,000 litre Diesel Spill		A	L-M	L-PA	M	N	R	M		N	n/a
			750,000 litre Diesel Spill		A	L-M	RSA	M	N	R	M		N	n/a
			SBM Spill		A	N-L	L-PA	S	N	R	H		N	n/a
			Subsurface Blowout –EL 1144 Example Well Site		A	M	RSA	M-L	N	R	M		N	n/a
			Subsurface Blowout – EL 1150 Example Well Site		A	M	RSA	M-L	N	R	M		N	n/a
Marine and Migratory Birds	s. 5(1)(a)(iii)	• Change in mortality / injury levels and bird health • Change in avifauna presence and abundance (behavioral effects) • Change in habitat availability and quality • Change in food availability or quality	100 litre Diesel Spill	See Table 18.2	A	L	L-PA	S	N-O	R	H	Ecological / Socioeconomic Context as summarized in Table 9.4 of the EIS	N	n/a
			1,000 litre Diesel Spill		A	M	PA-LSA	M	N	R	M		N	n/a
			750,000 litre Diesel Spill		A	M	RSA	M	N	R	M		N	n/a
			SBM Spill		A	N-L	L-PA	S	N	R	H		N	n/a
			Subsurface Blowout –EL 1144 Example Well Site		A	M-H	RSA	M-L	N	R	M		S	Low
			Subsurface Blowout – EL 1150 Example Well Site		A	M-H	RSA	M-L	N	R	M		S	Low
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	• Change in mortality / injury levels and health • Change in habitat availability, quality and use • Change in food availability or quality	100 litre Diesel Spill	See Table 18.2	A	N-L	L-PA	S	N-O	R	H	Ecological / Socioeconomic Context as summarized in Table 10.5 of the EIS	N	n/a
			1,000 litre Diesel Spill		A	L	L-PA	S	N	R	M		N	n/a
			750,000 litre Diesel Spill		A	L-M	RSA	S-M	N	R	M		N	n/a
			SBM Spill		A	N-L	L-PA	S	N	R	H		N	n/a
			Subsurface Blowout –EL 1144 Example Well Site		A	L-M	RSA	M-L	N	R	M		N	n/a
			Subsurface Blowout – EL 1150 Example Well Site		A	L-M	RSA	M-L	N	R	M		N	n/a
Special Areas	s. 5(1)(b)(i)	• Possible change in environmental features and/or processes • Possible change in human use and/or societal value	100 litre Diesel Spill	See Table 18.2	A	N-L	L-PA	S	N-O	R	H	Ecological / Socioeconomic Context as summarized in Table 11.4 of the EIS	N	n/a
			1,000 litre Diesel Spill		A	L-M	L-PA	M	N	R	M		N	n/a

VC	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effects	Project Activity (Potential Event)	Mitigation	Residual Effect Characterization							Other Criteria Used to Determine Significance (Ecological / Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty			
			750,000 litre Diesel Spill		A	L-M	L-RSA	M	N	R	M		N	n/a
			SBM Spill		N	-	-	-	-	-	H		N	n/a
			Subsurface Blowout –EL 1144 Example Well Site		A	M	RSA	M-L	N	R	M		N	n/a
			Subsurface Blowout – EL 1150 Example Well Site		A	M	RSA	M-L	N	R	M		N	n/a
Indigenous Peoples	s.5(1)(c)(i) s.5(1)(c)(iii)	• Change in Health and Socio-Economic Conditions • Change in the Current Use of Lands and Resources for Traditional Purposes • Change in Physical and Cultural Heritage • Change in any Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance	100 litre Diesel Spill	See Table 18.2	N	-	-	-	-	-	H	Ecological / Socioeconomic Context as summarized in Table 12.10 of the EIS	N	n/a
			1,000 litre Diesel Spill		N	-	-	-	-	-	H		N	n/a
			750,000 litre Diesel Spill		N	-	-	-	-	-	M		N	n/a
			SBM Spill		N	-	-	-	-	-	H		N	n/a
			Subsurface Blowout –EL 1144 Example Well Site		A	N-L	RSA	M-L	N	R	M		N	n/a
			Subsurface Blowout – EL 1150 Example Well Site		A	N-L	RSA	M-L	N	R	M		N	n/a
Fisheries and Other Ocean Uses	s. 5(2)(b)(i)	• Direct interference with fishing activity or exclusion from established fishing grounds • Damage to fishing gear or vessels • Decreases in the abundance, distribution and actual or perceived quality of fisheries resources • Direct contact with and damage to in situ component • Interference with other marine activities	100 litre Diesel Spill	See Table 18.2	A	N-L	L-PA	S	N-O	R	H	Ecological / Socioeconomic Context as summarized in Tables 13.5 and 13.6 of the EIS	N	n/a
			1,000 litre Diesel Spill		A	L	PA	M	N	R	H		N	n/a
			750,000 litre Diesel Spill		A	L	PA-RSA	M	N	R	M		N	n/a
			SBM Spill		A	N	L	S	N	R	H		N	n/a
			Subsurface Blowout –EL 1144 Example Well Site		A	L	RSA	M-L	N	R	M		N	n/a
			Subsurface Blowout – EL 1150 Example Well Site		A	L	RSA	M-L	N	R	M		N	n/a

18.4 Environmental Monitoring and Follow-up

This EIS also identifies and describes proposed environmental monitoring and/or follow-up activities which may be required or proposed for the Project.

18.4.1 Follow-up

Under CEAA 2012, a follow-up program is defined as a program for "verifying the accuracy of the environmental assessment of a designated project" and "determining the effectiveness of mitigation measures".

Based on the information presented in this EIS, and the findings and conclusions of the environmental effects assessment, a follow-up program will be undertaken in consideration of sensitive benthic habitat in the following circumstances:

- When a planned well site is located within an identified FCA, or
- In an area where the results of the pre-drill seabed investigation and subsequent review by DFO and C-NLOPB indicate that monitoring is required.

The purpose of the program would be to determine the effectiveness of mitigation measures in protecting the sensitive benthic habitat. It may include parameters such as:

- Post-drilling seabed core samples or sediment traps to measure drill cuttings deposition; and/or
- Post-drilling visual assessment using high-definition images / video

If exploration wells are planned to be drilled under the circumstances identified above, a follow-up monitoring plan will be developed and submitted for DFO and the C-NLOPB for review prior to commencement of drilling.

As illustrated throughout this EIS, the Project does not require or propose the use of new or different equipment, methods or other technologies during its planned components and activities. Rather, it uses standard and proven exploration components and methods, for which potential environmental issues are well understood and fully manageable through existing and effective mitigation measures. This has allowed for an overall high level of confidence in the environmental effects predictions made as part of this EIS. Therefore, follow-up is not proposed for any of the other VCs considered in the EIS, including species at risk. Moreover, the results of Nexen's regulatory, Indigenous and stakeholder engagement program to date have not identified concerns that require or could be addressed through any such follow-up.

In the event of a spill, an EEM program may be required, depending on the nature and magnitude of the spill. This EEM program will be developed in consultation with the C-NLOPB and other relevant regulatory authorities.

18.4.2 Future Environmental Monitoring, Observations and Communications

18.4.2.1 Environmental Monitoring and Observations

Monitoring is often undertaken to help assure the regulator and the public that environmental regulations and requirements are being followed. Requirements for compliance monitoring are outlined in the *Offshore Waste Treatment Guidelines* and the *Environmental Protection Plan Guidelines.* Nexen's Project-related plans detail the environmental compliance monitoring plans, procedures, and reporting requirements that it will follow, and must be reviewed and accepted by the C-NLOPB in order to obtain an Operations Authorization.

In addition to reporting requirements outlined in Nexen's own plans and procedures, Nexen will be responsible for reporting to the C-NLOPB in accordance with the *Drilling and Production Regulations* and *Data Acquisition and Reporting Guidelines*. The *Drilling and Production Guidelines* and *Data Acquisition and Reporting Guidelines* describe the operational testing, measurement, monitoring, and reporting requirements to be conducted during an exploration well drilling program. These are primarily related to engineering and technical aspects of the operations. Any incidents will be reported in accordance with the *Incident Reporting and Investigation Guidelines*.

As described in Section 9.6 of this EIS, Nexen will develop and implement an operational monitoring program for marine birds throughout the course of the Project. This monitoring program will be designed in consultation with applicable regulatory authorities, and will include the following:

- A trained Environmental Observer will be onboard the MODU to record marine bird sightings during Project operations, which will be undertaken in accordance with the Canadian Wildlife Service's pelagic seabird monitoring protocol, and will utilize other available information and sources, including the guide for pelagic seabirds of Atlantic Canada.
- A report of the seabird monitoring program, together with any recommended changes, will be submitted to the C-NLOPB and ECCC-CWS on a yearly basis in the format recommended by the regulator.
- During Project operations offshore, regular searches of vessel decks will be undertaken and accepted protocols for the collection and release of any birds that become stranded will be implemented by qualified and experienced personnel, in accordance with applicable regulatory guidance and requirements and the ECCC-CWS bird handling permit.

In addition, as described in Section 10.6, Nexen will develop and implement an operational monitoring program for marine mammals during VSP surveys for the Project. Nexen will consult with applicable regulatory authorities in the design of the program, which will involve the following:

- A trained MMO will be onboard to record marine mammal and sea turtle sightings during VSP survey operations.
- Visual monitoring for the presence of marine mammals and sea turtles within a pre-determined exclusion zone will take place during VSP operations where a seismic sound source array is used.
- Observational / shutdown procedures will follow the SOCP for marine mammals and sea turtles.
- A report of the observational program will be submitted annually to the C-NLOPB and DFO, including documentation of marine mammal and sea turtle sightings.

- Any vessel strikes involving marine mammals or sea turtles will be reported to DFO within 24 hours.

18.4.2.2 Engagement and Communications

Nexen will continue to communicate with Indigenous groups throughout the operational life of the Project, as required or requested, through established and/or additional engagement processes. The specific nature, frequency, subject matter and format of such future engagement will be determined in discussion with the Indigenous groups. Nexen will also continue to review these inputs and perspectives as the Project progresses, and will consider them in its Project-related planning and decision-making as applicable. These on-going engagement processes are intended to allow for continued discussion of Project related activities and issues as they may arise, as well as to collaboratively plan any revised management measures throughout the life of the Project.

Nexen will develop and implement an Indigenous Communities Fisheries Communication Plan (ICFC Plan). Indigenous communities will be invited to provide comments on the ICFC Plan. The ICFC Plan will be designed to:

- Identify communication objectives;
- Identify a list of participants and key contacts;
- Provide instructions for updating participants during the operational activities;
- Provide opportunities for feedback and further exchange of information; and
- Serve as a reference for expected communication during the unlikely event of a major incident such as a spill (see Chapter 16).

Nexen has committed to on-going communication and information exchange mechanisms with fishers and other ocean uses throughout the Project. These are intended to allow for the on-going consideration of Project related activities and any issues that might arise during the Project, and to work collaboratively to assess, plan and implement any further mitigation measures that might be required during the life of the Project. These mechanisms will provide continuing opportunities for consultation and evaluation and to understand and address any changes in the fisheries environment or science survey plans. In years when exploration activities are planned, Nexen will provide an annual update of planned activities to fishers and fish processors that will include timing of exploration activities and locations of planned wells

18.4.3 Adaptive Management

As noted above, Nexen has identified and committed to a number of measures and processes to avoid or reduce the potential for adverse interactions with, and effects upon, fisheries and other marine activities and users in the region and Indigenous groups. These include on-going communication and cooperation mechanisms throughout the operational life of this Project, which are intended to allow for continued discussion of Project related activities and issues as they may arise during Project implementation, as well as to cooperatively and collaboratively plan and implement adaptive management measures throughout the life of the Project.

Nexen will provide an EA update to the C-NLOPB. The EA update will provide an overview of planned activities as defined by the scope of the Project, update on recent and on-going engagement activities

and their outcomes, an overview of any new information regarding commercial fishing activities, updates to Species at Risk, if applicable evaluate the continued applicability and validity of the EIS predictions and mitigation measures. A copy of this EA update will be sent to all Indigenous groups and stakeholders identified in Chapter 3. Nexen will follow up with Indigenous groups and stakeholders regarding questions arising from the EA update.

18.5 Summary of Predicted Environmental Changes and Effects and Their Relationship to Federal Jurisdiction and Decisions

In keeping with the requirements of Sections 5(1) and 5(2) of CEAA 2012, this EIS assesses and evaluates the potential environmental changes and resulting environmental effects that may result from the Project, including:

a) Changes that may be caused to components of the environment that are within federal government jurisdiction (CEAA 2012, Section 5(1)(a)
b) Changes that may be caused to the environment that would occur on federal lands, in another province, or outside Canada (CEAA 2012, Section 5(1)(b)
c) Changes that may be caused to the environment and that are directly linked or necessarily incidental to a federal decision (CEAA 2012, Section 5(2))

This section of the EIS Summary provides an overview of these factors, in order to address the following requirements of the EIS Guidelines (Part 2, Section 6.2):

- *The EIS will include stand-alone sections that summarise those changes that may be caused by the project on the components of the environment listed in paragraph 5(1)(a) of CEAA 2012, namely fish and fish habitat, aquatic species and migratory birds.*

- *The EIS will include a stand-alone section that summarises any change the project may cause to the environment that may occur on federal lands or lands outside the province in which the project is to be located (including outside of Canada).*

- *In situations where the project requires one or more federal decisions identified in section 5(2), the EIS will also include a stand-alone section that describes any change that may be caused by the project on the environment that is directly linked or necessarily incidental to these decisions (e.g. changes to commercial fishing).*

Each of these factors are addressed in a comprehensive and fully integrated manner as part of the environmental effects assessment presented in this EIS. Therefore, the sections below provide a brief identification of the various environmental components, potential changes and effects that relate to each of these factors and requirements, and an indication of where and how these have been addressed.

The EIS Guidelines (Section 6.1.9) also state that "*Should there be the potential for a change to the environment arising as a result of a federal decision(s), or on federal lands, lands in another province or lands outside Canada, the EIS will include baseline information on the environmental component likely to be affected (if this information is not already covered in other subsections of these guidelines)".* As noted in the definition of the RSAs and in the existing environment descriptions in Chapters 5-7,

these sections of this EIS provide environmental baseline information for the identified VCs and the potential effects of the Project on them throughout their geographic extents.

Finally, Section 6.3.8 of the EIS Guidelines require that if there is the potential for a change to the environment arising as a result of a federal decision and/or occurring within or outside areas of federal jurisdiction, the EIS should include a description of the specific project components involved and an assessment of any other VCs (not already covered in other subsections) that may be affected. Again, these items and requirements are addressed in a fully integrated and comprehensive manner as part of the scope of the Project assessed, and as part of the VCs identified and focused on in the environmental effects assessments presented in the EIS.

18.5.1 Changes to Environmental Components within Federal Jurisdiction

Section 5(1) of CEAA 2012 states that the environmental effects that are to be taken into account in relation to a designated project include:

(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:
(i) fish and fish habitat as defined in subsection 2(1) of the Fisheries Act,
(ii) aquatic species as defined in subsection 2(1) of the Species at Risk Act,
(iii) migratory birds as defined in subsection 2(1) of the Migratory Birds Convention Act, 1994

18.5.1.1 Planned Project Activities

Marine Fish and Fish Habitat

As described in Chapter 8, offshore exploration drilling and associated activities may affect marine fish and fish habitat in a number of ways, including possible injury, mortality, or behavioral effects due to noise or other disturbances in the marine environment, effects to benthic communities through the alteration of marine habitats, and change in habitat quality from discharges or accidental events. The Project will interact with fish and their habitats within the LSA, although as described in Chapter 8 it will entail a relatively limited and temporary environmental disturbance at any one location. Marine discharges will be treated prior to release in accordance with regulatory requirements, reducing associated potential effects on the environment. Modelling of released drilling fluids and cuttings has also indicated that these would be characterized by relatively localized seabed footprints, limiting the potential for smothering effects on benthic species. To further reduce the potential for effects on sensitive benthic habitats (corals), pre-drill seabed investigations will be carried out and appropriate set-backs applied where these species are observed within the immediate vicinity of a planned well site. Acoustic noise from VSP will largely be directed into the well, resulting in reduced area of potential effect over a short period. Furthermore, employed mitigation measures, including gradual ramp-up of the seismic sound source, promote temporary avoidance of the area by mobile species while operations are ongoing and will help to reduce exposure to species. Other planned Project activities likewise represent localized and short-term activities and associated environmental disturbances, which are addressed through standard mitigation measures and which are not anticipated to adversely affect this VC. With the limited potential effects and the implementation of the mitigation measures outlined in the EIS, the Project is not predicted to result in significant adverse effects to marine fish and fish habitat.

Marine and Migratory Birds

Potential interactions with, and effects on, marine and migratory birds as a result of the Project relate primarily to possible attraction and/or disorientation of the birds around the MODU and vessels due to artificial light sources, as well as possible effects from noise and possible waste discharges. As described in the environmental effects assessment for this VC (Chapter 9), the planned activities associated with this Project will operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. Platform attraction associated with lighting and increased foraging opportunities may lead to some increased potential for mortality or injury, particularly in the spring and fall migration periods and during specific meteorological conditions such as fog or inclement weather; however, these conditions and potential effects will be short-term in duration. Discharges from the MODU and vessels may interact with birds both directly and indirectly, particularly in the winter months when thermoregulatory stress is highest. These discharges will be managed through adherence to relevant regulations and guidelines. Vessel and aircraft traffic in nearshore environments may also have potential interactions due to disturbance effects, but they will be reduced through adherence to common traffic routes and avoidance of known bird colonies. Because such effects are anticipated to be limited and spatially and temporally restricted, and given the typically wide variation in marine bird presence and distribution in space and time throughout this large offshore area, the number of individuals potentially affected by the Project is not expected to have population-level effects. With the limited potential effects and the implementation of the mitigation measures outlined in the EIS, the Project is not predicted to result in significant adverse effects to marine and migratory birds.

Marine Mammals and Sea Turtles

As discussed in Chapter 10, potential interactions with, and effects on, marine mammals and sea turtles as a result of the Project relate to possible injury or disturbance from the movement, noise, light, and possible waste materials associated with the MODUs and other related vessel and aircraft traffic. The primary pathways for potential residual effects on marine mammals are those associated with increases in underwater noise and vessel traffic that may result in change in mortality or injury or change in habitat quality or use (behavioral effects). Other potential pathways include change in food availability or quality (effects on prey) or change in health (contaminants). Mitigation measures that will be applied across a number of Project components and activities and that are designed to prevent or reduce potential interactions with and effects on marine mammals and sea turtles are as summarized in Section 18.2. With the limited potential effects and the implementation of the mitigation measures outlined in the EIS, the Project is not predicted to result in significant adverse effects to marine mammals or sea turtles. The Project will therefore not result in significant adverse environmental effects on this VC.

18.5.1.2 Potential Accidental Events

An accidental event such as a large-scale oil spill would have adverse effects on each of the VCs discussed above, which would vary between VCs and would depend on the specific nature and magnitude of the event and its duration and geographic extent. While for most VCs such an accidental event would not likely to result in significant adverse environmental effects according to the significance definitions developed and used in this EIS, others such as marine and migratory birds could conceivably see significant effects depending on the amount of oil spilled, time of year, types and numbers or birds present at that time in the affected area, and other factors. As described in Chapter 16, a variety of

preventative measures have been identified to avoid an accidental event along with a number of potential response measures to mitigation potential effects.

18.5.1.3 Summary

With the implementation of mitigation measures, the Project is not likely to result in significant environmental effects on the above listed environmental components within federal jurisdiction (including both stable species and species at risk).

18.5.2 Changes to the Environment that Would Occur on Federal Lands, in Another Province, or Outside Canada

Section 5(1)(b) of CEAA 2012 states that the environmental effects that are to be taken into account in relation to a designated project include: (b) Changes that may be caused to the environment that would occur on federal lands, in another province, or outside Canada.

As described in Section 1.3 of the EIS, Project activities are planned to take place within the offshore marine environment, which are considered “federal lands” under CEAA 2012. CEAA 2012 specifically defines “federal lands” as including “(i) the internal waters of Canada, in an area of the sea not within a province, (ii) the territorial sea of Canada, in an area of the sea not within a province, (iii) the exclusive economic zone of Canada, and (iv) the continental shelf of Canada.”.

A number of regulatory regimes have jurisdiction over various components of the environment within and adjacent to the Project Area, LSAs and RSAs. For marine fish and fish habitat, for example, the Government of Canada manages fish stocks within the 200-mile EEZ and sedentary species occurring on the extended continental shelf. In these areas, the federal *Fisheries Act* provides protection to commercial, recreational, and Aboriginal fisheries by managing the fish resources and habitats that support these activities. Groundfish outside the EEZ and the benthic organisms beyond the extended continental shelf are managed by NAFO. In addition, in the case of the special areas VC, the Project Area, LSA and RSA overlap with areas that have been designated as protected or otherwise special by provincial, federal and international organizations and processes. In the case of the latter item, this includes a number of NAFO FCAs and VMEs off Eastern Newfoundland. In addition, commercial fisheries are undertaken by a number of foreign countries in the Project Area and larger LSAs and RSAs, which includes fisheries and resources that are managed by NAFO.

18.5.2.1 Planned Project Activities

Planned and routine Project activities that take place within the area of Canada’s jurisdiction are not anticipated to result in environmental changes and direct interactions that will extend to the environment outside Newfoundland and Labrador or outside the marine waters under the jurisdiction of Canada. Although the direct environmental zone of influence of the Project components and activities that occur within the area of Canada’s jurisdiction are not expected to extend to other jurisdictions, the Project may, however, affect environmental components (such as migratory fish, aquatic species, or birds) that extend to and/or move both within and outside the areas under the jurisdiction of Canada, as described in detail in Chapters 6 and 8 to 11. In addition, Project activities or disturbances that will or may interact with areas of international jurisdiction (such as NAFO designated special areas or in locations where internationally managed fishing or other marine activities are taking place), has the potential to affect

these environmental components. As the Project and its associated activities and resulting environmental interactions are not planned to occur on-land or otherwise in proximity to Indian Reserves or Treaty lands, it will not affect these areas of jurisdiction.

As illustrated throughout this EIS and summarized above, the Project is not likely to have significant adverse environmental effects. The preceding section provided a summary of the effects assessment for each of the identified VCs that come under federal jurisdiction, namely marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles. The predicted effects on the other VCs are summarized here.

In terms of the special areas VC, a number of onland, marine and coastal areas within and off Eastern Newfoundland have been designated as protected under provincial, federal and/or other legislation and processes, or have been formally identified through relevant forums and processes as being otherwise special or sensitive due to their ecological, historical and/or socio-cultural characteristics and importance.

Given its location over 400 km offshore, the Project will not occur within, or otherwise interact directly with, any of the existing provincial or federal Parks or Historic Sites (including World Heritage Sites), Ecological Reserves, Wildlife Reserves, MPAs or AOIs, Canadian/voluntary FCAs, Marine Refuges, Migratory Birds Sanctuaries, IBAs or other locations that have been designated as protected on or around the Island of Newfoundland. The Project Area likewise does not overlap with either of the identified EBSAs, VMEs or preliminary RMAs off Eastern Newfoundland. While the Project Area does overlap with small portions of NAFO FCAs, there are no associated prohibitions of marine activities such as that being proposed as part of this Project. Only one of these NAFO FCAs overlaps with any part of the ELs themselves. In addition, a number of special areas (VMEs, NAFO FCAs, a Marine Refuge, a preliminary RMA, IBAs, a provincial park and a provincial ecological reserve) that do not overlap with the Project Area are located within the general vicinity of (within 50 km of) the LSA boundary. The identified general vessel/aircraft traffic route from Eastern Newfoundland to the Project Area does, given its possible commencement at a onland port site in this region, occur within one kilometer of several coastal special areas in Eastern Newfoundland (a National Historic Site and an IBA), and within 5 km of several others. It also overlaps with one EBSA offshore. Given the overall nature of the planned Project activities, the overall and defining physical, biological, and socioeconomic environments within these areas will not be adversely affected by the Project. Many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized and of a short-term nature at a given location, and the implementation of the various mitigation measures outlined throughout this EIS will serve to further address direct (or indirect) potential effects on the existing environmental characteristics and conditions of these special areas.

Given the nature, location and timing of the various planned Project activities and associated Project induced changes to the environment likely to occur as a result of this Project, it is not expected to have adverse effects on Indigenous people. As most Project-related activities will take place in the offshore marine environment, hundreds of kilometers from land and over 635 km from the closest Indigenous community, and because associated emissions and other disturbances are expected to be localized and short-term in nature (Chapters 8 to 10), they are unlikely to extend to or affect the health (physical or social) and well-being or other socioeconomic conditions of Indigenous peoples. While some Indigenous groups are known to undertake commercial fishing activities off Eastern Newfoundland, including some fisheries included under commercial-communal licences, Nexen is not aware that these

or other Indigenous peoples assert Aboriginal or Treaty rights within or near the Project Area and LSA. Moreover, there are no documented food, social or ceremonial licenses in this area, nor do Indigenous groups otherwise undertake the current use of lands and resources for traditional purposes in this area. There are also no other known aspects of the physical and cultural heritage of these groups located in proximity to, or which may otherwise be affected by, the Project. The environmental effects analysis also indicates that few of the marine associated species that are known to be used by these Indigenous groups are known to migrate through the Project Area / LSA and are thus likely to be affected by Project activities and disturbances, and the implementation of the various mitigation measures and procedures outlined throughout this EIS will serve to further address potential effects on these resources. There is little potential for the availability or quality of resources that are currently used for traditional purposes by Indigenous groups to be reduced or negatively affected in other ways as a result of the Project, especially to a nature and to a degree that would alter the nature, location, timing, intensity or value of these activities or the health or heritage of Indigenous peoples.

For fisheries and other ocean uses, possible Project-induced changes may result from a loss of access due to the presence of a temporary safety zone around Project equipment during exploration activities, potential interference between Project components and fishing equipment, and potential biophysical changes to fish and fish habitat from Project activities that may the availability of commercial fish resources. These interactions and potential effects may result in lost time, reduced catch volumes, lower economic returns on catches, and increased operational costs for fishers and other ocean users in the area. However, due to the localized nature and duration of Project activities, and the implementation of standard mitigation measures, it is predicted that there will be no significant adverse environmental effects on this VC (Chapter 13). Although the presence of the MODU and its safety zone and other planned Project activities will temporarily reduce access for fishing and other activities in certain areas, such interactions will be localized, temporary, and reversible once Project activity ceases at a well or survey site. To help mitigate such effects, Notice to Shippers, Notice to Mariners, and other communication protocols will be implemented. In the unlikely event of fishing gear damage, Nexen will implement a fishing gear damage compensation program, consistent with previous oil and gas exploration drilling programs.

18.5.2.2 Potential Accidental Events

For all VC considered in this EIS, an accidental event such as a large-scale oil spill could possibly result in transboundary effects by extending to other provinces of Canada or outside an area of Canada's jurisdiction, as well as affecting environmental components (such as migratory fish, birds, or marine mammals and sea turtles) that extend across or move both within and outside the areas under the jurisdiction of Canada (Chapter 6). A variety of oil spill prevention and response measures have been identified and are committed to in this EIS, which will help safeguard against such an accidental event occurring, as well as responding to one in the unlikely event it did, thereby reducing the potential magnitude, extent and duration of its potential effects.

18.5.2.3 Summary

With the implementation of mitigation measures, the Project is not likely to result in significant environmental effects upon any environmental component, in any jurisdiction.

18.5.3 Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions

Section 5(2)(a) of CEAA 2012 requires consideration of additional changes that may be caused to the environment that are directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the designated project.

The primary federal government approval related to this Project that is of relevance to the scope and content of this EIS is the associated requirement for EA approval under CEAA 2012. Each of the various potential changes to the environment and associated effects that have been assessed and evaluated in this EIS are therefore linked directly to the eventual federal EA decision that will be made following review of this EIS.

A number of other federal decisions will or may also be required in relation to the Project. Petroleum exploration activities offshore Newfoundland and Labrador are, for example, managed by the C-NLOPB, a joint federal-provincial regulatory agency. The C-NLOPB's responsibilities under the Accord Acts include but are not limited to: the issuance and administration of petroleum and exploration and development rights; administration of statutory requirements regulating offshore exploration, development and production; and approval of Canada-NL Benefits and Development Plans. In addition to EA requirements under CEAA 2012, the C-NLOPB also requires that project-specific EAs be completed in relation to certain types of petroleum activities in the Canada-NL Offshore Area, as part of their required authorizations pursuant to Section 138(1)b of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Act* and Section 134(1)b of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act*. It is understood that the EA review for this Project under CEAA 2012 involves C-NLOPB participation, and that this EIS will also address the C-NLOPB's EA requirements.

The C-NLOPB's regulatory responsibilities also include issuing a number of authorizations and approvals pertaining to offshore oil and gas exploration projects and activities in the Canada-NL Offshore Area. Before carrying out work or activity respecting oil and gas operations, an Operator must, for example, obtain an OL which is a prerequisite for oil and gas activity in the Canada-NL Offshore Area involving fieldwork. Various authorizations and approvals are also required for specific activities and other matters, which may - depending on the specific nature and scope of the activity being planned - include applying for and obtaining an OA from the C-NLOPB. Other required approvals may also involve the approval of certain documents, plans or other matters as specified by the relevant legislation or regulations, or the approval of specific activities conducted under an earlier authorization. Of particular relevance to this Project, an ADW is required for operations involving drilling within or under the marine environment. A separate ADW is required for each well in a proposed drilling program, with the process involving the provision and review of specific details about the drilling program and well design.

Fish and fish habitat, and the potential effects of the Project on this VC, are subject to the relevant provisions of the federal *Fisheries Act* and its associated regulations, which provides protection to commercial, recreational, and Aboriginal fisheries by protecting the fish resources and habitats that support these activities. Authorization from the Minister of Fisheries and Oceans under Section 35(2)

of the *Fisheries Act* has not been required in the past for offshore exploration drilling projects. Therefore, such an authorization is not anticipated to be required in support of this Project.

The introductory chapter of this EIS (Chapter 1, Table 1.2) provides a detailed listing of various other federal legislation and regulations and potential permitting requirements that will or may be relevant to the Project.

As the above noted federal decisions and approvals – such as the required OL, OA and ADW from the C-NLOPB – would have the effect of allowing the various planned Project components and activities to be initiated and completed, each of the various potential environmental changes assessed and evaluated in this EIS (on all VCs) "would be directly linked or necessarily incidental to a federal authority's exercise of a power". These environmental components and predicted environmental changes and effects are identified and summarized in the preceding sections and are therefore not repeated here.

Table 18.5 provides a summary of the Project's potential effects on the atmospheric environment (see Chapter 14), as well as, for completeness, several environmental components that are not assessed as VCs in the EIS, namely the: 1) terrestrial environment; and 2) aquatic (freshwater) environment.

Table 18.5 Other Potential Environmental Changes Linked to the Exercise of Power or Performance of Duty or Function by a Federal Authority

Environmental Component	Potentially Applicable Federal Decisions or Actions	Summary of Potential Environmental Changes
Atmospheric Environment	C-NLOPB licences, approvals and authorizations (see Table 1.2)	• Considered as a specific, individual VC in the environmental effects assessment (Chapter 14). This includes a description of the anticipated types and levels of Project-related air emissions and their contribution to regional ambient air quality and GHG levels. • This analysis shows that the Project will make a negligible contribution to regional atmospheric emissions, and these emissions will be within applicable regulations and standards. • Chapter 14 also provides a description and discussion of the various mitigation measures that will be put into place related to Project-related air quality and GHG emissions.
Terrestrial Environment and Aquatic Environment	C-NLOPB licences, approvals and authorizations (see Table 1.2)	• The Project is located in the marine offshore environment and will not involve the development and use of new on-land or nearshore infrastructure or Project-related expansions or modifications to existing infrastructure. • Project-related supply and support activities will take place at existing, established onshore industrial facilities

Environmental Component	Potentially Applicable Federal Decisions or Actions	Summary of Potential Environmental Changes
		operated by a third-party contractor, which have been previously approved under applicable regulatory processes and currently provide services to multiple offshore and other industrial operators. No Project-specific construction or expansion of such facilities or other on-shore infrastructure is required or planned. • Support vessel and aircraft services and their transits to and from the Project Area from these supply bases will likewise be contracted from third party suppliers and will travel directly to active drill sites in the Project Area, avoiding interaction with the coastal or on-land environments. • Planned Project activities will therefore not interact with or adversely affect components of the terrestrial or aquatic environments. • The environmental effects assessment for accidental events (and particularly, for a large-scale oil spill) in Chapter 16 assessed the potential for oil to reach land, and concluded that this is extremely unlikely to occur, particularly with the implementation of oil spill prevention and response measures.
Others	C-NLOPB approvals and authorizations (see Table 1.2)	• No other components of the biophysical or socioeconomic environments have been identified as having the potential to be directly and adversely affected by the Project which would necessitate or justify their inclusion in the environmental effects assessment presented in this EIS.

Finally, Section 5(2)(b) of CEAA 2012 also requires the EIS to consider effects other than those listed above resulting from the above described federal decisions on (i) health and socioeconomic conditions, (ii) physical and cultural heritage, or (iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Relevant aspects of the human environment that have the potential to be affected by the Project are considered and addressed as part of the other socioeconomic VCs identified above. This includes other commercial and recreational ocean users, physical heritage items such as shipwrecks, and other components. Human health is considered within those VCs to the extent that it may be affected by the Project's planned activities or unplanned events, such as through direct interaction with other marine activities and equipment or through resource tainting in the unlikely event of a spill. However, given the location of most Project components and activities over 400 km offshore (and thus, from communities

or human activities), adverse effects on other aspects of human health are not anticipated. Similarly, given the nature and location of the Project, adverse effects on other components of the human environment, such as on-land or nearshore aspects of communities and their overall socioeconomic conditions and well-being, physical and cultural heritage, and other aspects of existing socioeconomic conditions in Eastern Newfoundland and beyond are not anticipated.

Although an accidental event such as a large-scale oil spill could potentially result in such effects to the human environment, the results of the oil spill modeling indicate little potential for oil to reach land or other otherwise affect people and communities and their health and well-being. A variety of oil spill prevention and response measures have been identified and are committed to in this EIS, which will help safeguard against such an accidental event occurring, as well as responding to one in the unlikely event that one did, thereby reducing the potential magnitude, extent and duration of its potential effects. With the implementation of these mitigation measures, the Project is not likely to result in significant adverse environmental effects on these components.

18.6 Conclusion

A summary of the predicted residual environmental effects on each VC are summarized in Table 18.6, including those that may result from planned Project activities, potential accidental events, and cumulative environmental effects.

Table 18.6 Summary of Predicted Residual Environmental Effects for Planned Project Activities, Possible Accidental Events, and Cumulative Effects

VC	Planned Project Activities	Potential Accidental Events		Cumulative Effects
	Significance of Residual Environmental Effects	*Significance of Residual Environmental Effects*	*Likelihood of Significant Effects*	*Significance of Residual Environmental Effects*
Marine Fish and Fish Habitat	N	N	n/a	N
Marine and Migratory Birds	N	S	Low	N
Marine Mammals and Sea Turtles	N	N	n/a	N
Special Areas	N	N	n/a	N
Indigenous Peoples	N	N	n/a	N
Fisheries and Other Ocean Uses	N	N	n/a	N
Atmospheric Environment	N	n/a	n/a	n/a

Key:
N = Not significant residual environmental effect (adverse)
S = Significant residual environmental effect (adverse)
n/a = Not Applicable
Note: See significance definitions provided for each VC in Chapters 8-14.

As illustrated throughout this EIS, each of the potential environmental interactions, resulting environmental changes and predicted environmental effects that may be associated with the Project can be avoided or otherwise mitigated through the use of good planning and proven operational practices, which are industry standard and/or are well established and outlined in relevant regulation and guidelines, and which have been identified and committed by Nexen as part of this EIS. Additional, Project and VC-specific mitigation measures have also been identified and committed to throughout this document, as required and applicable (Table 18.2).

Overall, the planned components and activities that will be associated with the Project will entail localized, and transient disturbances in the marine environment at any one location within an EL and time throughout the operational life of this exploration program, the potential effects of which will be effectively avoided or minimized through the various regulated or otherwise implemented mitigations referenced above. The Project is therefore not anticipated to disturb, displace, or otherwise affect marine fish, birds, mammals, sea turtles, Indigenous peoples, fisheries or other human components and activities in such a way that causes adverse, sustained and detectable effects to populations, species at risk or human activities in any location.

Nexen recognizes that of particular concern to government regulators, Indigenous groups, stakeholder organizations and the general public is the potential for an accidental event to occur during offshore drilling activities, and the potential environmental consequences of any such incident. Although each of the potential accidental events that have been assessed herein (batch spills and blowouts) have the potential to adversely affect any biophysical and socioeconomic components that come into contact with them, clearly the potential for, and possible magnitude of, any such effects will depend on the specific probability, nature, degree and other characteristics of the event, including the type and amount of material spilled, its eventual geographic extent, oceanographic conditions and the persistence of these materials in the environment.

As noted through the oil spill probability analysis completed for this EIS, a blowout event is an extremely unlikely occurrence, which would be avoided through Nexen's planned spill prevention measures. If such an event were to occur, it would be acted upon quickly and effectively with Nexen's planned response measures. In addition, the subsequent (post-EA) regulatory approvals process that apply to the Project are amongst the most rigorous and stringent in the world. Through those regulatory processes, operators are required to demonstrate that they have the ability and capacity to undertake such activities in a safe and environmentally responsible manner through various project design measures, operational procedures, and response mechanisms. These mitigations will help to ensure that such an accidental event does not occur, and in the very unlikely event that one did, will allow Nexen to respond in a timely and effective manner, thereby reducing any potential environmental effects.

The Project is not likely to result in significant adverse environmental effects.

Nexen is committed to obtaining all required permits, approvals and authorizations for the Project, and the company and its contractors will adhere to these and all relevant regulations and guidelines in planning and implementing the Project that is the subject of this EIS. This includes the various mitigations identified and committed to in the preceding sections, the implementation and effectiveness of which will be directed, managed, and monitored in accordance with Nexen's applicable policies and procedures. Nexen will also prepare and submit EA Updates to the C-NLOPB in relation to this multi-

year exploration program, that will describe the previous year's Project activities, any recent and on-going engagement activities and their outcomes, as well as outlining the proposed exploration work for the coming year and evaluating the continued applicability and validity of the EIS predictions and associated mitigations.

In conclusion, the Project represents an environmentally and socially responsible, technically feasible and economically beneficial means of conducting offshore exploration drilling and other associated activities within Nexen's existing ELs in the Flemish Pass region. It will allow Nexen to meet its exploration and expenditure obligations under the terms of these licences, while at the same time providing important direct and indirect socioeconomic benefits to the province as well as contributing information and experience to help advance the future development of the Newfoundland and Labrador offshore oil and gas industry and the overall economy of the Atlantic region and Canada.